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EUROPA 1&2

Customers´ Manual

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EUROPA I and II Customers' Manual

The purpose of the manual is to give to EUROPA I/II customers a general outline of the launchers, their performances and the launching facilities.

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Neuilly, 1st July 1971

EUROPA I and II Customers' Manual

This manual is intended for use by Europa I/II customers and any changes resulting from the availability of new or more recent information will be authorised by formal amendments to be issued by the ELDO Secretariat. Each copy of the document will be numbered and the name of the recipient recorded by the ELDO Secretariat Documentation Service.

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Amendments will take the form of amended pages to replace existing ones. These replacement pages will bear the revised Amendment List Sheet Number (i.e. a new page for insertion will be numbered AL.1).

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1. INTRODUCTION

1.1 Foreword

1.2 Purpose of the Manual

CHAPTER 1 - INTRODUCTION

1.1 Foreword

The EUROPA I/II launchers now under development are part of a joint European effort to achieve an autonomous capability in the satellite launching field. The European Space Vehicle Launcher Development Organisation (ELDO) is responsible for the development and construction of the launchers.

ELDO has its own launching facilities and can undertake the injection of stallites into orbit. Operations are conducted from the ELDO Equatorial Launching Base in the Guiana Space Centre at Kourou (French Guiana).

The development programme is still in progress but construction for users has already started, therefore some information or data related to launcher performance and constraints are not yet available or are subject to continuing evolution. All information or data supplied by this manual are derived from six different sources :

- Design goals and development achievements
- Mathematical models
- Trials assessments from the first ten EUROPA I firings (F1, F2, F3, F4, F5, F6/1, F6/2, F7, F8, F9)
- Trials assessments from other launcher firings (i. e. Diamant B firings for EUROPA II 4th stage)
- Description of Guiana Space Centre (CNES document)
- Technical clauses of CNES-ELDO contract N° CTR 106

New or updated information will be available from the Multi Stage Reference Vehicle (MSRV) tests and from launch F11 in 1971, and from launch F12 which is foreseen in the first half of 1972.

The MSRV tests, which include the static firing of the first stage were performed in order to qualify the launch facilities and their compatibility with the EUROPA I/II launchers.

The F11 and F12 launches will qualify the EUROPA I/II vehicles, including the inertial guidance system. Mathematical models related to the behaviour of the four-stage configuration will be checked through these flights.

As more information becomes available from future firings, it will be introduced into the manual.

At present, two operational launches per year are envisaged from F13 onwards. Improvements and modifications of the EUROPA I/II basic version are envisaged in order to meet the requirements of sophisticated scientific missions.

1.2 Purpose of the Manual

The purpose of the manual is to give to EUROPA I/II users a general outline of the launchers, their performance and the launching facilities.

In particular, it is aimed to .

1. Give a basic description of the launchers.
2. Describe the performance capability of the launchers
3. Define the major spacecraft design and operational constraints due to the launchers and field operations.
4. Describe the launching facilities, regulations and operations.
5. Specify integration requirement and procedures
6. List documentation and management procedures

As a mission emerges from the early planning stages, users, being in touch with ELDO on a continuing basis, will receive more complete information and data than those presented in this manual.

2. LAUNCHER DESCRIPTION

2.1 General Configuration

2.2 Structure (including spin-up system)

2.3 Propulsion and Pressurisation Systems

2.4 Primary Power Supply

2.5 Guidance and Control System

2.6 Sequence Safety and Separation

2.7 Telemetry Systems

2.8 Reference Axes and Alignment Tolerances

CHAPTER 2 - LAUNCHER DESCRIPTION

2.1 General configuration

The geometrical configuration of both the vehicles is given in fig. 2.1. The main difference between the two vehicles is that the 4th stage (perigee) is installed inside the fairings together with the spacecraft.

A tapered adapter is installed at the front end of the 1st stage between the large diameter of the Blue Streak and the smaller diameter of the 2nd stage Coralie, which is capable of transmitting the end loads imposed by the upper stages.

The 2nd stage is connected to the 1st through a skirt which is a continuation of the tapered adapter of the 1st stage and keeps sufficient clearance between the stages to accommodate the four motors of the 2nd stage.

The separation plane between the 2nd and the 3rd stages is 1075 mm above the 2nd/3rd stage installation plane. The cylindrical section (middle skirt) is jettisoned after separation. The separation plane between the 3rd stage and the fairings, but for a few millimetres, is the same as that of the 3rd stage/spacecraft separation in the Europa I vehicle and the top of the 3rd stage in the Europa II vehicle.

Fairings are designed to protect the equipment installed inside the compartment (i.e. spacecraft and perigee motor) from aerodynamic heating during the boost flight through the lower part of the atmosphere.

The datum planes of the vehicles Europa I and II refer to the zero level plane of the CSG which lies four metres above the zero level (IGN reference level).

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The datum planes of the vehicle standing on the launch pad then result as follows :

Datum Location	Datum Identification[*]	Europa I (mm)	Europa II (mm)
1st stage pick up points	datum 1.11	13,998	13,998
1st/2nd stage separation plane (1st stage side)	datum 1.34	29,719	29,719
2nd/3rd stage installation plane (2nd stage side)	datum 2.34 (plane N° 1)	35,218	35,218
2nd/3rd stage separation plane (3rd stage side)	datum 3.12 (plane N° 2)	36,293	36,293
3rd stage/spacecraft separation system installation plane (3rd stage side)	datum 3.35 (plane N° 3)	39,017.6	-
Fairing installation plane (3rd stage side)	datum 3.34 (plane N° 4)	39,028.6	39,028.6
Bottom of the perigee stage motor	(plane N° 5)	-	39,038.1
3rd stage/perigee separation plane (side perigee stage)	datum 4.12 (plane N° 6)	-	39,652.6
Spin rocket plane	-	-	39,707.6
Equipment case installation plane	datum 4.23 (plane N° 7)	-	40,599.6
Perigee/spacecraft separation plane (spacecraft side)	datum 5.11 (plane N° 8)	-	40,825.6
Spacecraft installation plane (spacecraft side)	datum 5.12 (plane N° 9)	-	40,851.6

Further information can be found in the Data Sheets N° 3/0/1.

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[*] The datum identification system in brackets is generally used in documents regarding the perigee stage.

2.2 Structure

2.2.1 1st stage

The structure of the 1st stage is made up of the following sections :

a) Separation Bay. The function of this section is to provide the connecting structure between the 1st stage and the upper stages. Shaped as a frustum of a cone the bay carries fittings for the explosive bolts and the spigots to locate the 2nd stage. Blow out efflux doors are set in this section to limit the interstage pressure during separation.

b) Bulkhead. This section of the structure divides the equipment bay from the separation bay. Its function is to protect the equipment bay and liquid oxygen tank dome from the efflux of the 2nd stage separation motor and serves as a mounting for electronic units in the equipment bay ; protection is assured by a 1.3 mm layer of ablative coating.

c) Equipment Bay. This section is a parallel-walled forward extension to the liquid oxygen tank. Its function is to transfer the end loads generated by the upper stages into the wall of the liquid oxygen tank and to accommodate electronic control and instrumentation equipment.

d) Tank Bay. The tank bay consists of two main sections : the forward liquid oxygen tank is a pressure-stabilised thin-skin structure and the rear kerosene tank is an externally-stringered structure stabilised at lower pressure. The basic configuration of the pressure vessels is cylindrical with ellipsoidal end closures.

The intertank diaphragm separating liquid oxygen from kerosene is also ellipsoidal convex side aft from the oxygen tank into the lower pressure kerosene tank. A parallel rear skirt extends aft from the kerosene tank to the propulsion bay junction. Access to the inside of the tank is possible through manholes in the centre of the front and rear domes.

e) Propulsion Bay. This bay houses the Rolls Royce RZ2/Mk III rocket engines and support equipment. Its main structural function is to transfer the engine thrust load to the tank section above.

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f) Heat Shield and Equipment Panniers. This section forms the rear end closure to the propulsion bay. The structure in aluminium alloy is protected by a stainless steel shield air-spaced from it by Ferodo pads. Glass cloth flexible gaiters provide a seal around the thrust chamber and a spring loaded sliding shutter covers the electrical disconnect panel after lift-off. Stainless steel box assemblies protect the working sections of the heat exchangers from external heat during flight.

g) External Structural Features. Two fairings protect the two break-up charges installed at the intertank diaphragm. Tubular cable ducts are installed outside the liquid oxygen tank between the break-up charges and equipment bay and the main instrumentation cable ducts.

Pressurisation pipes for liquid oxygen and kerosene tanks are also run externally on the tanks.

Stainless steel fairings are used to streamline the propellant level sensors and kerosene tank relief valves, all of which project through the skin of the tank.

2.2.2. 2nd stage

The 2nd stage structure is composed of three main sections :

a) Rear Skirt. This section is made up of two halves and is shaped as a frustum of a cone, and, together with the separation bay of the 1st stage, provides the tapered adapter between the 1st and 2nd stages. The structural function of this section is to transfer the end loads imposed by the upper stages.

b) Tank Bay. This section is made up of two parts : the forward N204 tank and the rear UDMH tank. The basic configuration of the vessels is cylindrical with ellipsoidal closures. Two frames at the ends of the tank sections are used for supporting the equipment on the front and the propulsion bay on the rear end. Between the front and rear frames there are two other frames for stiffening the whole of the structure.

c) Front skirt. The main function of this section is to transfer the loads generated by the 3rd stage, perigee and payload compartment to the 2nd stage. The front skirt is made up of two terminal frames connected by a double corrugated sandwich. Stiffening frames are mounted between the terminal frames.

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2.2.3 3rd stage

The 3rd stage structure is divided into four main assemblies : upper section, middle skirt, lower skirt, engine support structure.

a) Upper Section. The upper section is made up of a cylindrical shell composed of a plain skin stiffened on the outside around its whole circumference by a longitudinally corrugated skin. The shape of the shell is held by an internal frame structure consisting of seven circumferential stiffeners.

A particularly rigid circumferential frame called the Main Strong Ring supports the propellant tanks, the engine mountings and,in Europa I or Europa II, the payload separation system or the perigee assembly, respectively.

The loads are transferred from the main strong ring to the outer shell by spot welded and riveted joints.

The payload, in the case of Europa I, or the lower skirt of the perigee assembly, in the case of Europa II, is supported by the thrust wall which is a ring-shaped plain-skinned plate with radial reinforcement of corrugated sheet. This is attached to the structure around its periphery. Holes are drilled to allow for electric cables.

The upper section cylindrical shell is provided with eight identical apertures corresponding to eight modules to permit installation of equipment and for connection to the ground systems. These apertures are covered by bolted flaps.

Other apertures are provided for propellant tank and propulsion system venting outlets and umbilicals. Two electrical umbilicals, for the 3rd stage and satellite, are mounted symmetrically with respect to the Y axis. Four telemetry antennae are fitted at the Z, Y, Zn, Yn axes.* The fairing ring is bolted to the upper section.

b) Middle Skirt. The structure of this section has the same design characteristics as the upper section. The upper edge is made up of a steel ring for connection to the upper section. Connection to the lower section is made by means of twelve explosive bolts symmetrically located around the periphery.

Apertures are provided in the middle skirt to allow assembly and disassembly work inside the erected 3rd stage. These apertures are closed with bolted flaps.

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* See para 2.8 for the definition of all reference axes.

Mechanical supports are also provided for certain equipment which is provided for stage separation and middle skirt jettisoning, i.e. the supports of the two booster rockets, opposite each other to the outer skin, and the linear shaped charges which are fastened both around the upper inner circumference (for circumferential separation) and vertically to divide the middle skirt into two halves which are then jettisoned.

c) Lower Skirt. This part of the structure has the same design characteristics as the middle skirt. It is fitted with eleven circumferential frames to hold the shape. The upper frame (separation frame) is equipped with fitments for the explosive bolts for connection with the middle skirt. Mechanical supports are also provided for the two cold gas generators which provide the interstage pressure necessary for 2nd/3rd stage separation.

d) Engine Support Structure. This part of the structure comprises the main engine frame, the engine beam and the two vernier engine frames.

The engine frame is provided to transfer the loads from the engine to the main strong ring through twelve diagonally disposed tubes welded together to form a kind of truss. Mountings for cable clamps and springs (to force the two halves of the middle skirt apart when jettisoned) are provided.

The engine beam connects the engine frame with the main engine gimbal frame, and it is formed of a box-like structure with corrugated reinforcements.

The vernier engine frames are made of tubes welded to form a truss. The mountings for the two helium bottles and vernier engines together with their gimbal frames, motor feed connections for fuel and oxidiser, the supports of the hydraulic actuators and the auxiliary control system, are provided in these frames.

2.2.4 Perigee stage (Europa II only)

The perigee stage structure is made up of three main parts :

a) Lower Skirt. This is the connecting structure between the 3rd stage and the composite of the perigee stage and payload. Its function is to provide a support to the perigee stage, capable of transmitting the end loads imposed by the upper parts of the structure.

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It is shaped as a frustum of a cone and the side wall is an integral part of the working structure being stabilised by two frames installed at both ends of the skirt : the lower frame is directly bolted on top of the 3rd stage by means of eight bolts, the upper frame carries the 3rd stage, perigee stage, separation system, i.e. the lower skirt remains with the 3rd stage after separation.

Openings in the side wall give direct access to the separation springs and pyrotechnic devices.

b) Main Structure. The main structure of the perigee motor is made up of : a) a small cylindrical lower skirt made of light alloy to transfer the loads from the upper stages to the 3rd stage, and which carries the upper ring of the separation system of the perigee stage, the device used to measure the relative separation velocity of the perigee stage with respect to the 3rd stage and the spinning rockets ; b) the solid propellant container, made of wound glass fibre, having the basic configuration of a cylindrical vessel with end closures shaped as a Cassini oval and opened at the poles ; c) a small cylindrical upper skirt made of light alloy for the transfer of the loads of the payload to the perigee stage, and carrying supports for the internal umbilical plug and the safety plug. On the upper part of this skirt a frame in light alloy connects the main structure to the equipment case.

c) Equipment Case. This is a tapered structure which is installed between the perigee motor and the pay-load. This structure supports all the electronic and electrical items necessary for the stage operation. The lower part of the structure is stiffened by a frame which transfers the loads to the main perigee stage structure. Supports are provided for : a) the installation of the bolts which connect the equipment case to the main perigee stage structure ; b) the shock absorbers of the tray which supports the electrical equipment. This tray, which is a flat honeycomb structure, has the form of a ring to allow direct access to the igniter of the motor.

Supports are provided outside on the case periphery for installation of the four telemetry antennae, the yo system and, at the top, the payload separation system.

2.3 Propulsion and pressurisation systems

2.3.1. 1st stage

The 1st stage of the EUROPA II satellite launching vehicle is powered by two Rolls Royce RZ2/Mk III engines using kerosene and liquid oxygen as propellants. The two engines, designated the RZ 12 propulsion system, develop a nominal thrust of 1,334,000 N at sea level, with a nominal lift-off acceleration of 1,3g.

The propellant feed to the engine thrust chambers is by means of turbopumps which are powered by a gas generator having liquid oxygen and kerosene taken from the high pressure side of these pumps("boot strap" system).

Exhaust gases from the gas generator are passed through heat exchangers which are used to generate gaseous nitrogen from stored liquid nitrogen. These generated gases are then used for propellant gas pressurisation which is required for structural integrity and to provide adequate NPSH (Net Positive S ction Head) for the propellant pumps.

Flight cut-off is usually started by a signal from a propellant depletion sensor but it may also be commanded from the ground. The latter procedure is used for static firing.

An adjustable delay timer is started by the cut-off signal (either from the depletion sensors or the ground). The setting is used to trim the system for minimum residuals of propellants. The cut-off signal generation by the timer causes pneumatic pressure to be applied to the closing side of the main propellant valves and the gas generator blade valve.

2.3.2. 2nd stage

Four engines designed for great expansion to operate in vacuum are provided for the 2nd stage propulsion. The engine feed is provided through the pressurisation of the main tanks

The pressurisation system is composed of a gas generator which generates gas at such pressure as to pressurise the tanks and feeds the actuators of the motors. The gas generator, which is installed in the front skirt of the equipment support, is made up of two small tanks of UDMH and N204 respectively and a combustion chamber. Hot gases are cooled by sprayed water before being used for the pressurisation of the main tanks.

Nitrogen bottles are used to operate the valves for starting and stopping the generator, the main tank pressurisation and the main valves to the motor. The gas generator is started by the sequencer at the time of 1st/2nd stage separation, but partial pressurisation already exists, having already been carried out on the ground.

2.3.3. 3rd stage

Three motors designed for vacuum operation are provided for the 3rd stage : a main motor and two verniers. The thrust ratio between the main motor and the two verniers is : 2300 kg./80 kg. The verniers have the task of vehicle stabilisation while the thrust of the main motor is directed and readjusted through the centre of gravity of the vehicle.

The engine feed is provided by the pressurisation of the main tanks.

The pressurisation system is composed of two helium bottles in parallel which feed the pressurisation pipes. A regulating system maintains the prescribed differential pressure between the fuel and oxidiser part of the tank. The pressurisation of the tank is carried out during the propulsive flight of the 2nd stage.

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2.3.4. Perigee stage (for Europa II only)

Propulsion system. The perigee stage has a solid propellant propulsion system ; the rocket nozzle is installed directly on the propellant container. A thermal shield is provided on the walls of the container for protection and to ensure the proper adherence of the propellant to the walls of the container.

The block of propellant is glued to the internal wall of the container and the central surface is shaped in order to obtain the desired pressure. The nozzle is fixed on the bottom end of the container and is made up of the following items : a) an input ; b) a neck in graphite; c) an insulating sleeve around the neck ; d) a neck fastener in titanium ; e) a coupling in titanium alloy which connects the neck fastener and the motor divergent ; f) a divergent in silicon.

The motor ingiter is installed in the front part of the propellant container in order to ensure the ignition of the propellant block in vacuum.

Spinning system. This system is made up of two to four rockets installed at equal intervals along the periphery of the lower part of the main perigee stage structure. These rockets are lit at the same time to develop an individual thrust of about 1250 N. For 0,87 sec in order to spin the combined perigee stage and spacecraft in an anticlockwise direction viewed from the rear at the desired angular velocity.

2.4 Primary power system

2.4.1. 1st stage

The system on board the 1st stage consists of 8 separate battery packs each containing 24 silver zinc cells of nominal 1.5 V 4.8 AH. The cells are assembled together in battery packs. The battery packs are tapped to cover the vehicle voltage demand. The 8 packs are divided into two main groups :

a) 5 packs for general electronic systems

Autopilot unit no·1	+ 28 V	1.6 A
	+ 20 V	2.7 A
	+ 9 V	1.1 A
Autopilot unit no.2	- 28 V	60 mA
	- 20 V	2.7 A
Instrumentation front	- 28 V	1.1 A
	- 24 V	4.2.A
Instrumentation rear	- 28 V	3.3 A
	- 24 V	.7 A
PCM telemetry	+ 28 V	3 A

b) Safety systems

Destruct no. 1	+ 36 V	2.8 A
	+ 10 V	.3 A
Destruct no. 2	+ 36 V	2.8 A
	+ 10 V	.3 A
Separation	+ 9 V	max 36 A for 3 sec
	+ 9 V	
	+ 9 V	
	+ 9 V	

The AC power requirements are met by a 400 cps 2 phase 26 V inverter. . This is driven from the autopilot 28 V battery pack and provides AC power to the autopilot system.

2.4.2 2nd stage

Individual power supplies are provided for the different systems of the 2nd stage, namely :

All functional equipment and autopilot	1 battery	+ 28 V	6 Ah
Sequencer	2 batteries	+ 7 V	250 mAh
	1 battery	+ 14 V	80 mAh
Telemetry	1 battery	+ 28 V	6 Ah
Igniters	2 batteries	+ 7.5 V	1.6 Ah
Safety	2 batteries	+ 28 V	3 Ah
Radar transponder	2 batteries	+ 28 V	3 Ah

2.4.3 3rd stage

A centralised power supply system is installed in the 3rd stage with two outputs available : one for the power devices (actuators, valves, etc.) and the second for the devices which are sensitive to voltage variations and operate only within tight tolerances (sequencer, telemetry, control electronics, rate gyros, etc.).

Two batteries of 28 V 16 Ah are then provided for the two types of loads.

2.4.4 Perigee stage (for Europa II only)

Three sets of batteries are planned on the perigee stage : one set of two batteries for the pyrotechnic devices, two batteries supplying the two sequencers, one battery for telemetry.

The capacity of each battery is such as to supply the normal load for one hour. The pyrotechnic batteries are doubled for reliability reasons.

All the batteries can be charged on the launch pad.

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2.5 Guidance and control system

2.5.1 General

The guidance and control system of the vehicle is required to fly the vehicle in a stable manner on the desired trajectory which is a programmed one for 1st stage flight and a currently optimised one later on. In particular, the autopilots of each stage must compensate for the changing aerodynamics and the decreasing of the moment of inertia as propellants are burnt and still retain stabilisation of various vehicle bending modes and the propellant sloshing modes.

Fig. 2.2 shows the block diagram of the vehicle guidance and control system. The attitude of the vehicle is sensed by an attitude reference system located in the 3rd stage and which operates for all three stages. A computer which is part of the guidance system, calculates the attitude errors and these are routed to the stage autopilot which is in operation.

The attitude errors in each of the three vehicle axes are combined in the autopilot with their respective vehicle rate signals. These rate signals are derived from single axis rate gyros installed in the stages.

Each error signal obtained in this way is then processed to give correct response to stabilise the vehicle by driving the actuators. In this way the thrust of the motors is vectored to keep the vehicle at the desired attitude. The inertial guidance system will initiate the switch-off sequence for the propulsion system when the obtained altitude and velocity, as computed by the on-board computer from the on-board measurements, are identical to the injection values defined for the mission.

2.5.2 1st stage autopilot

This autopilot is composed of two units : main unit A and servo amplifier unit B. The first unit processes the combined output signals of the computer and the rate gyros into deflection commands to the actuators. The transfer functions of the autopilot can be changed every 8 seconds of flight in order to suit the changes of the vehicle mass distribution, aerodynamics, etc.

The position of the three rate gyros is chosen to optimise the stabilisation of the vehicle bending modes, i.e. pitch and yaw rate gyros are located on the rear skirt of the 2nd stage, while the roll gyro is in the 1st stage equipment bay.

2.5.3 2nd stage autopilot

The autopilot of the 2nd stage accepts the steering commands from the inertial guidance system and controls the vehicle during 2nd stage flight. The autopilot gain changes 6 times to match variations in vehicle MOI due to propellant burning.

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2.5.4 3rd stage autopilot

This autopilot is designed in order to maintain as long as possible the thrust of the main motor directed through the centre of gravity of the vehicle, leaving to the two vernier engines the task of attitude stabilisation.

By periodically adjusting the main motor thrust direction to compensate for large steady demands, such as misalignment torques, a sampling system ensures that the vernier actuators do not exceed their angular rate for any appreciable time.

2.5.5 Secondary attitude control system

This system is installed in the 3rd stage and its main purpose is to orient the vehicle in a predetermined attitude during the coasting phase in order to direct the perigee stage so that the transfer orbit may be achieved (see 2.4.6). Although this system has been specifically designed for the perigee mission, it is also available as an option in Europa I in order to increase the accuracy of the injection into orbit of the payload. The weight of the system is 20 kg which are available for the payload in Europa I missions when the system is not required.

The secondary attitude control system is a digital pulse width modulation control system, i.e. eight cold gas jets are operated by pulses having a fixed repetition rate and variable length.

The method of operation is shown in the block diagram, Fig. 2.3. Attitude angular errors and angular rate signals in pitch, yaw and roll are multiplexed by a command unit driven by the 3rd stage sequencer into the input analogue unit. These signals, representing the position errors and angular rates of the same angle, are combined in an adder and limited in amplitude (according to the maximum length of pulse duty cycle). The resulting command voltage U is then converted into a digital code (7 bits plus a sign bit) in an analogue/digital converter. The voltage level determines the duty cycle 'h' of the pulse, i.e. the time the valve remains open, and this is achieved in the voltage time converter.

However, in order to generate command pulses, a threshold level χ of the signal must first be attained, and a pulse of a minimum duration h_{min} is generated accordingly.

The command pulses generated by the voltage/time converter are then applied to the appropriate pair of jets in order to correct the attitude.

The selection of the jets is made by the multiplexer command which selects the input signals and the pair of jets to which the output signals must be applied at the same time.

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As both χ and h_{min} may be externally selected through a threshold selector, which is connected with the stage sequencer, the sensitivity of the system may be changed according to a planned programme stored in the sequencer. This possibility has been envisaged in order to minimise the cold gas consumption when long parking orbits are required and it is necessary to keep the 3rd stage attitude within certain limits applicable to the platform performance.

2.5.6 Perigee stage (for Europa II only)

No guidance system is envisaged for the perigee stage which is aligned in a predetermined direction by the 3rd stage secondary attitude control and separated.

After separation, the vehicle direction is first stabilised by the spinning system (described in para. 2.3.4) and then the main motor is lit up, putting the vehicle into the transfer orbit.

When the vehicle has reached the transfer orbit, and the payload is released, a yo system is operated in order to avoid any possible collision between the payload and the spent perigee during the thrust decay phase.

This system consists of a weight attached to the end of a wire which when released changes the perigee momentum. The stage will then start a Poinsot movement i.e. the residual thrust will not be directed towards the satellite.

The yo system is made up of :

- a weight and the attached wire
- an attachement point on the stage structure for the wire
- a pyrotechnic device to hold the weight in place.

The system is installed near the upper end of the stage. The planned mass is 0.3 kg on a 4 m long wire.

2.6 Sequence safety and separation

Flight safety for satellite launchings requires that the flight path of the vehicle does not violate any predetermined boundary nor threaten any ground installation within a given area. In the event of hazardous conditions arising in flight, means must be provided to :

a) disperse unused propellants and explosives before impact by destroying the vehicle in flight, or

b) terminate propulsion phase and allow the complete vehicle to impact in a safe area.

Stage separation must a) be smooth and clean without the possibility of collision after separation and b) the spent stage must not be damaged by the exhaust gases of the live upper stage.

2.6.1 1st Stage

The command receivers are located in the 2nd stage (see para 2.6.2). On receipt of a command, the 2nd stage logic will route an appropriate signal to the 1st stage via 1st/2nd stage electrical interface.

The 1st stage system outlined in Fig.2.4 comprises the following principal components :

- Flight safety separation logic unit (FSSLU)
- Explosive break-up charges
- Engine cut solenoids
- Explosive bolts for stage separation
- Propellant depletion systems.

a) FSSLU. This is the heart of the 1st stage safety and separation logic, and consists of a number of solid state logic paths whose function is to process correctly the various input signals and produce output commands, according to flight requirements, with respect to time elapsed from vehicle lift-off. For this latter purpose, an electronic timer is provided within the unit. Where it has been considered necessary, logic paths have been duplicated and electronic safety switches provided. The various functions are :

Command break-up. On receipt of this command from the 2nd stage, the logic circuits will close the command safety electronic switches connecting the explosive break-up charges to the firing batteries.

Inadvertent separation. Two closed conducting loops pass across the 1st/2nd stage electrical interface connectors. When stages separate, the continuity of these loops is broken. In case of inadvertent separation, i.e. occurring other than by the planned separation sequence, the breaking of the loops initiates a logic process which terminates in connection of the explosive charges to the firing batteries. This action is inhibited once the separation sequence is started by the depletion signal.

Command cut-off. On receipt of the cut-off command from the second stage, the appropriate command and safety electronic switches close and energise the two 1st stage engine cut solenoids, thus causing engine shut-down. In this case, the separation of the stages does not take place.

Engine cut by propellant depletion. On receipt of either lox or kero depletion signals, the FSSLU will set the required logic path to :

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- Stop the 1st stage engines
- Prepare 1st/2nd stage separation
- Send 2 simultaneous signals to start the sequencers in the 2nd stage

1st/2nd stage separation. At a predetermined time, after the receipt of the sequencer start signal, the 2nd stage provides two separate signal pulses to the 1st stage. The first pulse will cause initiation of the upper detonator of each explosive bolt causing a fracture of the top half of the bolts, while the second pulse (delayed 15 ms with respect to the first one) causes the fracture of the lower half thus ensuring clean and certain separation.

b) Explosive Break-Up Charges. Two units are fitted to the exterior of the vehicle at the junction of the lox and kero tanks. Either of the units has sufficient energy to rupture both lox and kero tanks. Lanyard operated devices hold each charge in a safe condition until approximately 0.7 sec after lift-off.

c) Explosive Bolts. Each bolt is fitted with two charges located in the hollow ends.

d) Propellant Depletion System. Level sensing devices are fitted in predetermined positions in each of the propellant tanks. As the contents of each tank become depleted, the sensing elements will be uncovered and a signal generated. This signal is passed to a time unit where it may be delayed within preset limits to allow for a particular flight programme.

e) Telemetry. All significant logic functions are monitored within the FSSLU and fed directly to the 1st stage PCM telemetry.

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2.6.2 2nd stage

The sequence separation and safety system in the 2nd stage is made up of the following items :

a) Sequencers. Two units having different logics but the same output are provided. The outputs drive a double set of relays which are connected in parallel in order to increase reliability. The following output commands are provided :

- Separation sequence of 1st/2nd stage
- Pressurisation sequence of the main tanks and the feed system
- Pressurisation of the pneumatic system of the engine actuators
- Ignition and cut-off sequence of the four engines.

The first sequencer is started 20 sec before lift-off. A signal (ABS) received from the 1st stage at the time of engine cut-off starts the 1st/2nd stage separation sequence and ignition of the engines. The second sequencer starts at lift-off.

At the end of the 2nd Stage powered flight, a reset signal Authorisation Coralie (AC) is routed to the 3rd stage to start the 2nd/3rd stage separation sequence.

An additional task of the 2nd stage sequencer is the change of the autopilot gain during 2nd stage flight.

b) Safety - The safety command system is installed in the 2nd stage and comprises two command receivers operating at 434 MHz with three units containing relay logic to provide, when ordered from ground,

- first stage engine-cut
- destruct command to first, second and third stage break-up systems.

The second stage break-up system on receipt of the destruct signal ignites the explosive cord installed along the propellant tank and fires the separation motor.

c) Separation - The 1st/2nd Stage separation is achieved by ignition of the explosive bolts which hold the two stages together. The solid fuel separation motor installed in the centre of the 2nd stage propulsion bay, which burns for two seconds, imparts to the vehicle a small acceleration sufficient, to hold the propellants in the bottom of the tanks avoiding cavitation and thus allowing even ignition of the four main motors.

2.6.3 3rd stage

The sequence separation and safety system of the 3rd stage is made up of the following items :

a) Sequencer. This unit provides a set of output signals to control :

- the pressurisation of the main tanks
- the fairing separation sequence
- the 2nd/3rd stage separation sequence
- the ignition and cut-off signals of the vernier and main motors
- the middle skirt separation
- the changeover signal from primary attitude control system to auxiliary attitude control system
- the third stage/satellite separation sequence (EUROPA I). The 3rd/4th stage separation sequence (EUROPA II).

Besides the signals for the Auxiliary Attitude Control System (AACS) during the free flight phase, as explained in para.2.5.5. the sequencer makes available all control and check frequencies necessary for the AACS Control Logic.

b) Safety System. On receipt of the destruct signal (duplicated) from the 2nd stage the ignition circuits for two perforation pistols (to rupture the diaphragm between the propellant tanks) are activated by electronic switches and relays within the Separation and Destruct Command Box (S.D.C.B.).

c) Separation System. This system comprises the ignition circuits for :

- explosive valve for helium tank pressurisation
- fairing explosive bolts, ballistic actuators and explosive plug.
- pressure gas generators)
- explosive bolts) 2nd/3rd stage separation
- booster rockets)
- flexible linear shaped charges } Middle skirt separation
- cable guillotines }

The above ignition circuits are completed by relay operation within the Electronic Containers (E.C.I. and E.B.II), commanded by signals from the Sequencer.

The ignition circuits for the following are completed by electronic switches within the S.D.C.B. commanded by the Inertial Guidance System via the sequencer (the A.A.C. system being optional for Europa I).

- explosive valve for Freon flow to secondary attitude control (A.A.C.) system.
- explosive bolts 3rd stage/satellite separation Europa I.
- explosive bolts 3rd stage/perigee stage separation Europa II.

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The 3rd stage/perigee or payload separation system is made up of a belt which holds in place the perigee stage or payload assembly. This system is described under chapter 4 para 4.1.1.3.

2.6.4 Perigee stage (for Europa II only)

The sequence separation system in the perigee stage is made up of the following equipment :

- Sequencer
- Pyrotechnic devices
- Perigee/payload separation system

a) Sequencer. The sequencer is started by the physical separation of the perigee stage from the 3rd stage and will perform in sequence the following orders :

- ignition of the spin motors
- ignition of the main engine
- perigee stage/payload separation
- release of the weight (Yo)

b) Pyrotechnic devices. The pyrotechnic devices are as follows :

- the igniters of the spin motors
- the igniters of the main engine
- the igniters of the release system of the weight (Yo)
- the igniters of the two bolts holding the belt of the perigee/payload separation system

c) The spacecraft separation system is designed to operate the separation of the payload at the end of the perigee burning phase while the vehicle is revolving around its longitudinal axis. Detailed information on this system is given under chapter 4 para 4.1.1.4.

2.7 Telemetry systems

Three types of telemetry system are installed on the vehicle : a pulse code modulation PTI Mk II manufactured by Philips Telecommunicatie Industrie for the 1st and 3rd stages, an FM/PM (AJAX system) for the 2nd stage, and the perigee PCM telemetry.

2.7.1 PTI Mk II Telemetry

This system carries low frequency information in time sampled and digitalised form, transmitted as frequency modulation on the R.F. carrier. High frequency information is frequency modulated on sub-carriers, and the sub-carrier frequency multiplex is then impressed on the R.F. carrier as PM.

The low frequency information is sampled by solid state commutator modules, each of which accepts 16 inputs. A total of 128 primary channels at a sampling rate of 20 s/sec. is provided, 4 of which are used for synchronisation. The remaining 124 can either be super-commutated at 40 and 80 s/sec (or possibly more), or sub-commutated at 5 and 1 1/4 s/sec., with corresponding variations in the number of channels available.

Each sample is converted into an 8-bit digital code which can be used in any one of the following ways :

7 data bits	resolution 1/128 plus parity check (standard channels)
8 data bits	resolution 1/256 (up to a maximum of 62 primary channels)
7 data bits	resolution 1/128 plus one event for two state ON/OFF information (up to a maximum of 62 events)

The overall capacity for low frequency information is

128 x 20 x 8 = 20,480 bits/sec.

For high frequency information 6 or 12 analogue channels, each of 2 kcs or 1 kcs bandwidth respectively, are available. These channels conform to I.R.I.G. standards, and combinations of channels of different bandwidths up to a total bandwidth of 120 kHz are possible.

The telemetry sets installed in the 1st and 3rd stages differ only in organisation of the measurement inputs and in carrier frequencies which are in the 220-260 Mcs and 136-138 MHz bands respectively.

Before lift-off, the transmission of the information content of the telemetry to the check-out equipment is both by landline and by radio link. During the flight of the vehicle, depending on the trajectory, the radio link may take place with the ground stations of Kourou (Guiana), Fortaleza (Brazil) and Brazzaville (Congo) where it is possible to record the transmitted data.

2.7.2 AJAX telemetry

This system is an FM/PM system, i.e. the multiplex signal is made up of a set of sub-carriers which modulate in phase a carrier of a VHF transmitter. Generally speaking, the AJAX telemetry allows the simultaneous transmission of 15 sub-carriers conform to the Irig (Inter Range Instrumentation Group) standard which have proportional bandwidths and the relative numbering is from 4 to 18.

When the maximum number of sub-carriers is used the Irig standard imposes an FM modulation of ± 7.5% deviation from the nominal sub-carrier frequency, with a modulation index of 5.

On the other hand, when a large bandwidth is required, the 5 upper channels numbered from 14 to 18 may be modulated with a frequency deviation of ± 15% from the nominal sub-carrier. In this case, the 5 channels cannot be used simultaneously.

A special channel, named G, of 125 Kc nominal frequency with a maximum deviation of ± 10% and a modulation index of 1, can be used when a very large bandwidth is required.

It is possible to commutate each channel in order to multiplex measurements at lower frequencies.

During the flight, the associated receiving ground equipment provides the recording of the multiplex signal and the relative demodulation.

2.7.3 Perigee stage PCM telemetry system (for Europa II only)

This system, compatible with the ground PTI telemetry receiving stations, is mounted in the perigee stage equipment case and is used to monitor various motor parameters, temperatures, flight dynamics and system functions. It is also used for check-out purposes before launch.

The telemetry system carries low frequency information which is time sampled and encoded into a NRZL digital code. The RF carrier is in the 136-138 Mc band and the radiation is circularly polarised, PCM/PM modulation being used.

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The information capacity and format are as follows :

Information rate	32,768 bits/sec
Word length	8 bits
Words per frame	32
Frames per format	16
Formats per second	8
Synchronisation code	2 words/frame
Frame identification	4 bits/frame
Overall accuracy	3 %
Number of analogue channels per format	44
Super commutation	x 2, x 8
Sub-commutation	$\frac{1}{16}$

The 44 analogue channel inputs are related to the following input levels :

23 (single ended) high level	0 to + 2 V
13 (double ended) high level	0 to + 2 V
8 (double ended) low level	0 to 500 mV
Source impedances	10 k

2.7.3.1 Power supply

Nominal	27 V ± 10%
Encoder consumption	2.3 W
Transmitter consumption	4.5 W

2.7.3.2 Aerial

The transmission is radiated by a turnstile aerial with four phased elements giving RH or LH circular polarisation.

The polar diagram of this aerial does not show any minimum of less than 10 db below the isotropic nominal value.

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2.8 Reference Axes and Alignment Tolerances

2.8.1 Range reference frame, fig. 2.5

This frame, indicated by OR, XR, YR, ZR is a frame fixed to the earth and therefore rotating with it.

The origin OR is coincident with the intersection of the local vertical with the launcher emplacement at the centre of the rectangle defined by the ends of the launcher release arms. The XR axis lies on the local horizontal plane and is directed to the east (i.e. 90°E from north). The YR axis is directed to the north (i.e. 0°). The ZR axis is directed upwards.

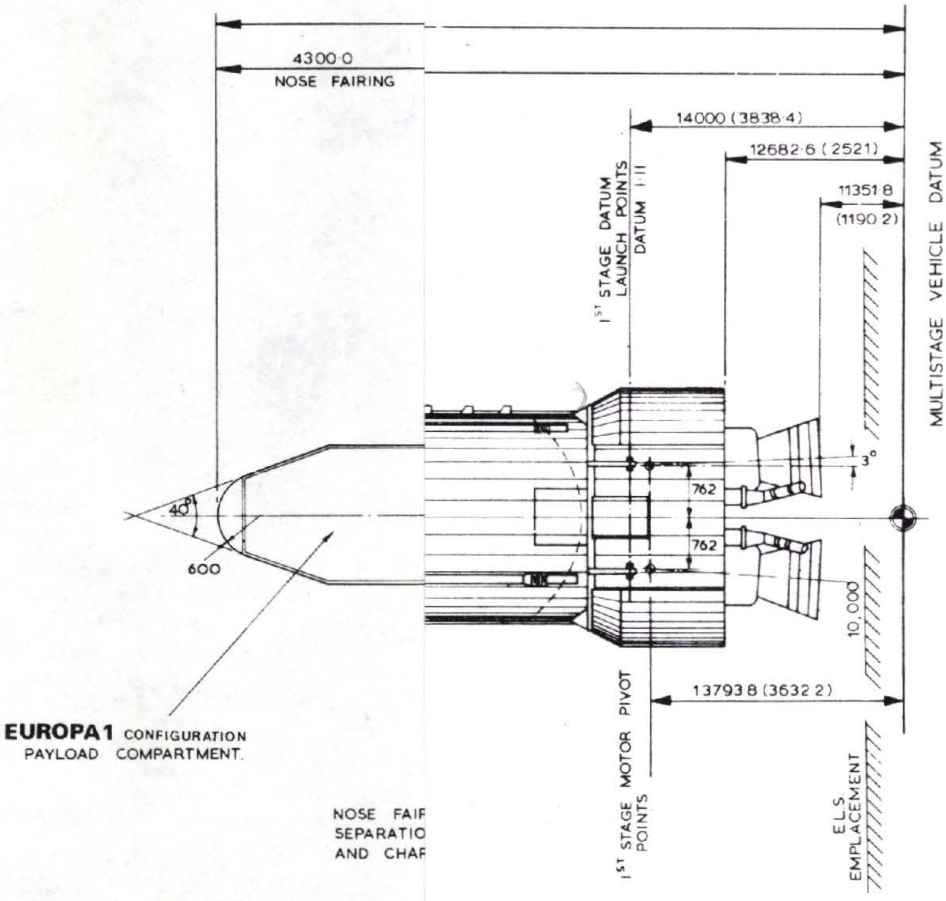
2.8.2 Vehicle reference frame, fig. 2.6

This frame, indicated by OXYZ, is a frame fixed to the vehicle.

The origin O is the intersection of the diagonals of the rectangle formed by the four 1st stage pick-up points, and, when the vehicle is standing on the launch pad, coincides with the origin OR of the range reference frame. The X axis (roll axis) is the vehicle longitudinal axis and, when the vehicle is standing on the launch pad, coincides with the ZR axis. The Z axis is defined as parallel to the line passing through the pivots of the two 1st stage motors (yaw axis) and, when the vehicle is standing on the launcher, coincides with the XR axis. The Y axis is perpendicular to the plane defined by XZ and is directed in order to form a right hand triad. When the vehicle is standing on the launch pad, it is in the opposite direction with respect to the OR, XR axes and is directed to the south.

2.8.3 Alignment tolerances

Details of the alignment tolerances of the various stages can be found in the ELDO document "Data Sheets" 3/0/5.



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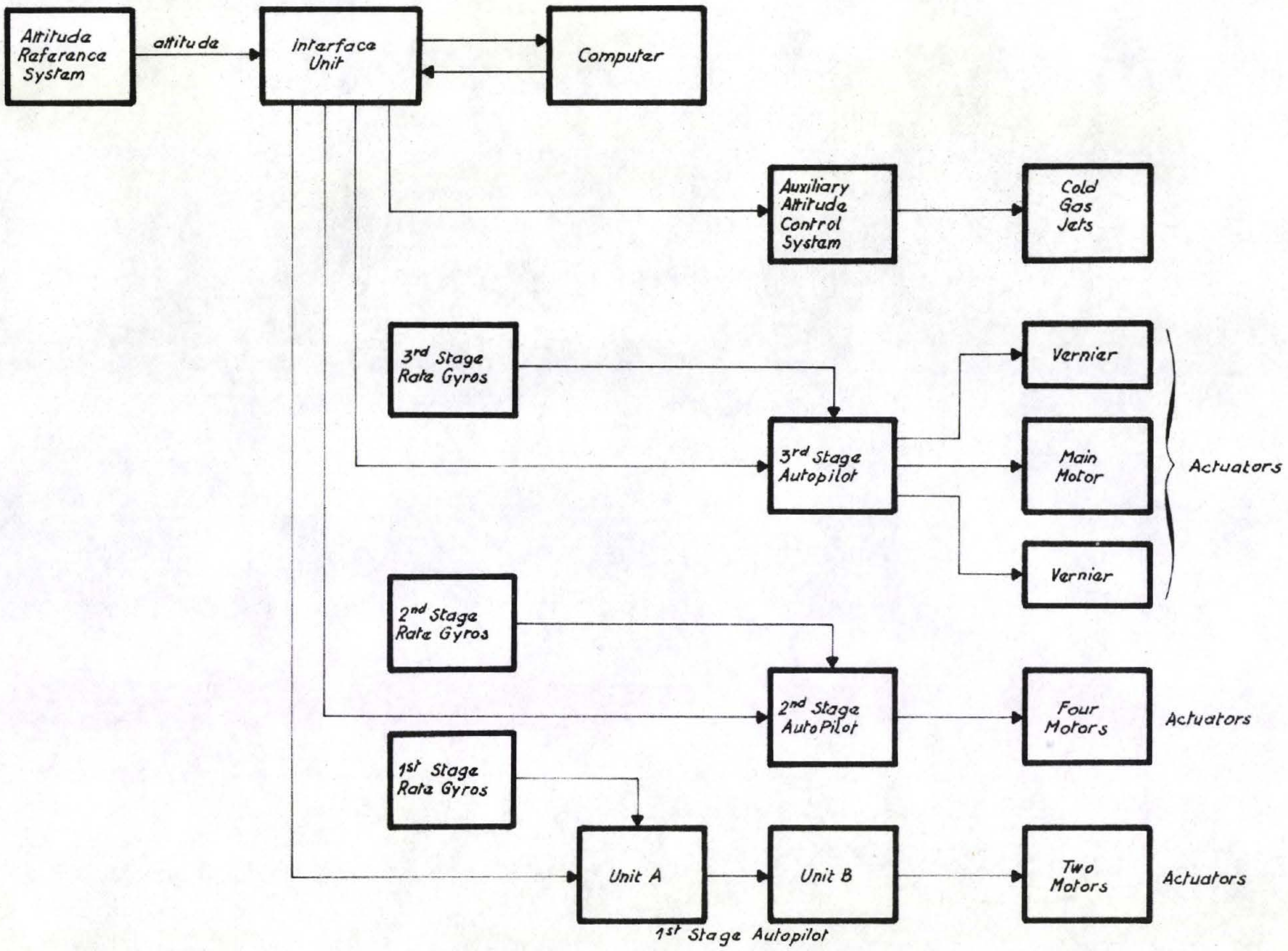
Vehicle Guidance and Control System of the Three Lower Stages

Figure 2.2



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Secondary Attitude Control System . Block Diagram

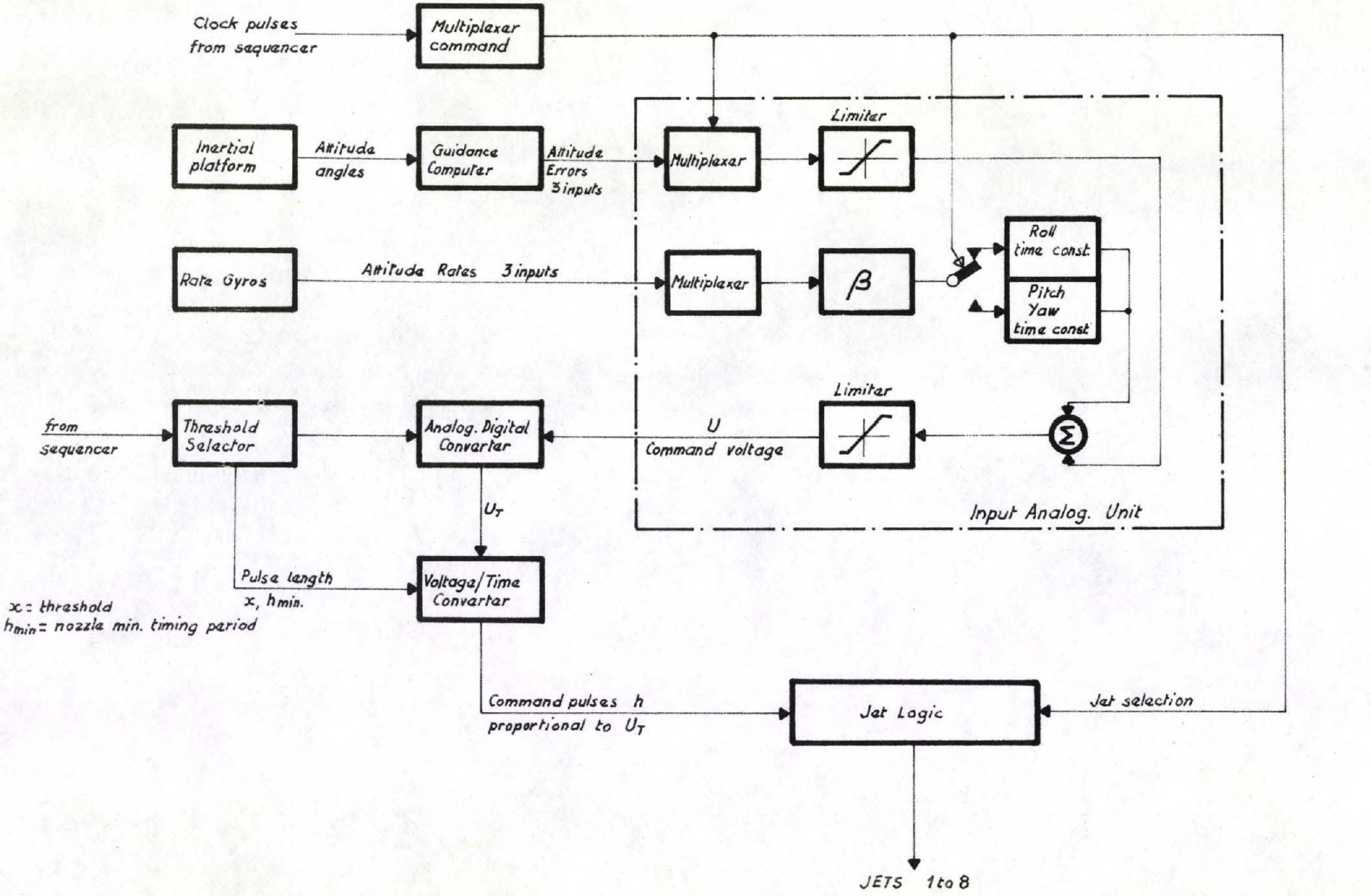
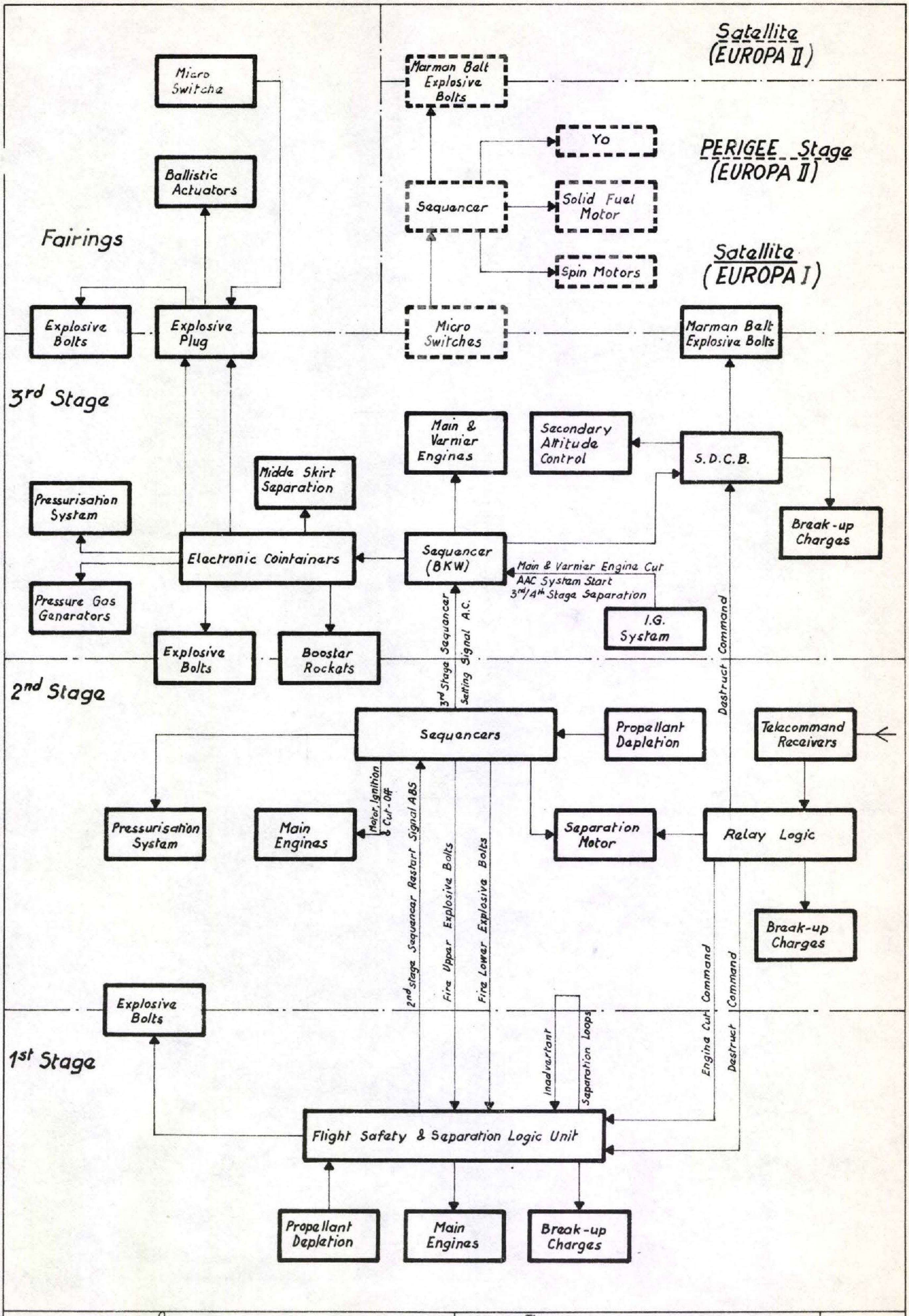


Figure 2.3



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Sequence safety & separation system

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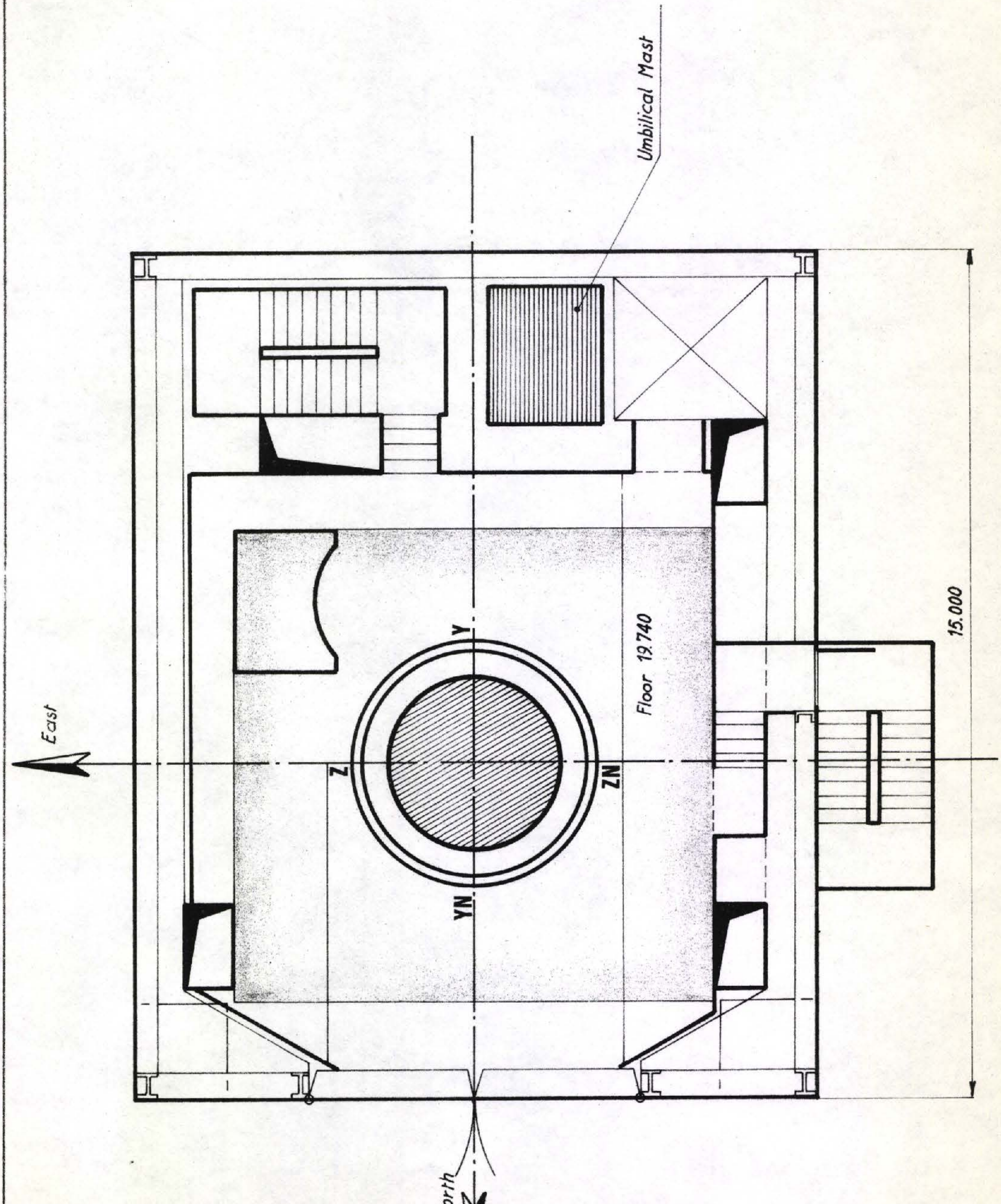
Launching Pad Orientation

Figure
2.5



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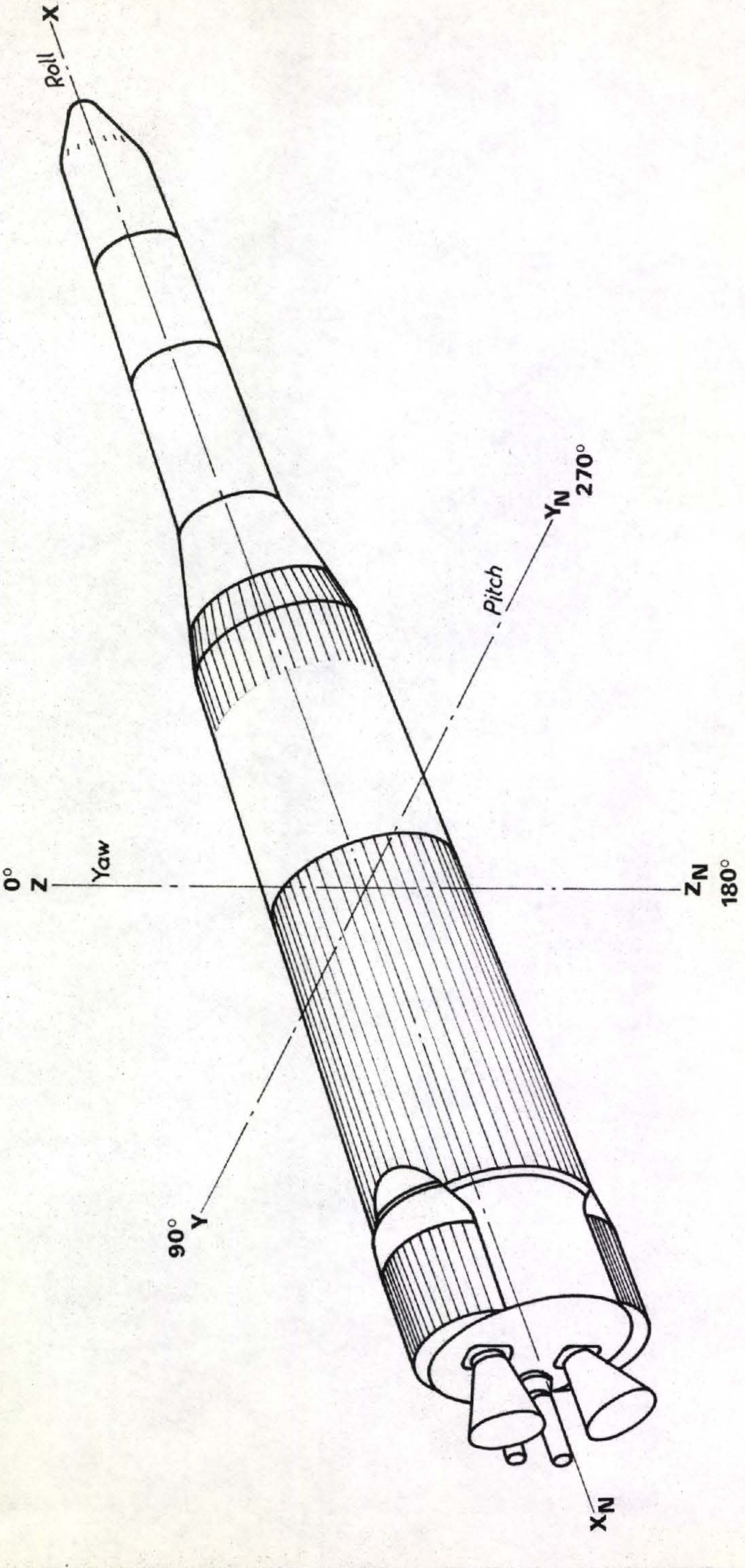

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3. PERFORMANCES

3.1 Introduction

3.2 Injection Procedures

3.3 Payload as a Function of Orbital Parameters

3.4 Dispersions

3.5 Description of a typical mission.

CHAPTER III - PERFORMANCE

3.1 Introduction

This Chapter describes the performance aimed at in the Europa I and II development programme. As knowledge of the behaviour of the vehicle improves, the performance will change and to avoid frequent modifications of the results presented, the performance is defined with a margin known as the "Planning Reserve" (cf. para. 3.3.1 a).

3.2 Injection procedures

3.2.1 Europa I Launcher

There is only one injection procedure for the Europa I launcher. This is direct injection by the successive firing of the three stages without an intermediate ballistic phase.

The turnover programme is chosen in order to optimise the payload for the orbit in question while respecting the vehicle's constraints during the atmospheric phase (1st stage flight).

Payload separation takes place either immediately after 3rd stage motor cut-off or after a ballistic phase lasting at least two minutes if the auxiliary attitude control system option is employed.

3.2.2 Europa II Launcher

For the Europa II launcher, three injection procedures are possible :

a) Circular parking orbit

The combined payload and perigee stage is injected into circular orbit. The perigee stage is ignited at the perigee of the final orbit. This method has the advantage of allowing a variable waiting period in parking orbit and of not imposing constraints in the choice of the argument of the perigee of the final orbit. On the other hand, it has the disadvantage of not generally being an optimum one since the perigee motor's characteristics are fixed once and for all.

b) Elliptical parking orbit

The choice of an elliptical parking orbit can compensate to some extent for the fact that the perigee motor is generally not optimum for the mission in question. It has the disadvantage of considerably restricting the choice of the argument of the perigee of the final orbit.

c) Direct injection

This method of injection consists of starting up the perigee stage motor immediately after that of the 3rd stage (while allowing the necessary time for orienting it prior to ignition). For such a procedure to be optimum from the payload aspect, injection must take place at the perigee of the final orbit. The perigee argument is thus imposed by the location of the launching site and the launch azimuth.

3.3 Payload as a Function of Orbital Parameters

3.3.1 Definitions

a) Launcher

The launcher definition used for calculating the performance is given in Table 3.1. This definition includes a quantity of 3rd stage propellant known as the "guidance reserve" necessary to compensate for the dispersions of the three-stage vehicle's flight. This guidance reserve is estimated at 85 kg.

The performance given below also makes allowance for an additional quantity of 3rd stage propellant, known as the "planning reserve", amounting to 60 kg. This reserve is designed to allow for any degradations that may occur during the development of the stages. If there is no degradation, this quantity will be fully usable. If flight tests reveal degradations, the planning reserve will be correspondingly decreased, the performance objective remaining unchanged. The degradation may take the form of increased dispersion of an important parameter; in this case, the planning reserve is decreased, with a corresponding increase in the guidance reserve.

As an indication, the availability of an additional 10 kg of 3rd stage propellant resulting from a reduction of the planning reserve allows an increase in the three-stage vehicle's payload of about 12 kg.

Finally, it should be noted that the guidance reserve of 85 kg guarantees injection into orbit of the 3rd stage within the given guidance accuracy (see below) with a probability $P_G = 99\%$. The payload may be increased if a reduction of this probability is acceptable. Fig. 3.1 gives the relationship between payload gain and decrease in P_G. If the guidance reserve is insufficient (probability $1 - P_G$), 3rd stage cut-off is brought about by the level sensors and the dispersions of the orbital parameters exceed the specifications, but this does not necessarily signify failure of the mission.

b) Payload

The payload is defined as everything that is :

- connected mechanically to the 3rd stage mounting plane for the Europa I vehicle;
- mechanically connected to Plane No. 8 of the perigee stage for the Europa II vehicle.

Any mechanical adaptor system is therefore considered as being part of the payload.

3.3.2 Performance* of the Europa I Vehicle (see Figs. 3.2 to 3.5)

Fig. 3.2 gives the variation of payload for easterly launches from Guiana as a function of orbital parameters. The orbits considered are :

- variable altitude circular orbits;
- elliptical orbits with perigee at 200 and 400 km and variable apogee.

The inclination of the orbits obtained is approximately 5.3°.

Fig. 3.3 gives the variation of the payload for similar missions but launching due north from Guiana. This corresponds to an inclination of about 83°.

Fig. 3.4 gives the variation of performance for intermediate launch azimuths.

Fig. 3.5 gives the relationship between launch azimuth and orbit inclination.

Note : The performance given for elliptical orbits corresponds to injection at the orbit perigee, which produces very nearly optimum performance.

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[*] The performance given for the two vehicles is valid for launch azimuths between -25° and 92° on either side of north. For other azimuths, each case must be considered separately (see Chapter VIII regarding the launch corridor).

3.3.3 Performance of the Europa II Vehicle (see Figs. 3.6 and 3.7)

In view of the large number of possible missions, Figs. 3.6 and 3.7 give performance curves for certain special cases. Fig. 3.6 gives three performance curves for easterly launches from Guiana. They correspond respectively to :

- an injection from circular parking orbit. For each point, the altitude of this orbit has been optimised. The perigee of the final orbit is equal to the altitude of the parking orbit, and its apogee is read on the horizontal axis.
- an injection from elliptical parking orbit, the perigee of the final orbit being fixed at 200 km. The perigee motor is ignited at the perigee of the parking orbit. The apogee of this orbit is optimised.
- direct injection, the perigee of the final orbit being fixed at 300 km.

Fig. 3.7 gives three performance curves for northerly launches from Guiana. For these launches, if a parking orbit procedure is called for, the nominal perigee motor cannot be used. Indeed, in all these cases it would place the payload in hyperbolic orbit.

The curves give respectively :

- the performance obtained from direct injection into an orbit with its perigee fixed at 300 km. The perigee motor is the nominal motor of the Europa II launcher.
- the performance obtained from injection using circular parking orbits of 200 and 300 km altitude. In this case the perigee motor has been optimised for each point. The assumptions regarding the inert mass of the stage tend to be pessimistic.

3.4 Dispersions

3.4.1 Axis systems

The dispersions at injection are given with respect to an axis system based on the nominal vehicle and defined as follows :

Origin	centre of gravity of the nominal vehicle at injection
Oz	local vertical, pointing away from the centre of the earth
Ox	perpendicular to Oz in the plane of the nominal orbit, in the direction of movement of the vehicle
Oy	completes the direct triad.

Errors in velocity Δu, Δv, Δw correspond to the errors in position Δx, Δy, Δz respectively.

In the case of the Europa II vehicle, the orientation of the satellite's kinetic moment after separation is given with respect to an inertial axis system based on the nominal 3rd stage immediately after 3rd/perigee stage separation.

OX_v	roll axis
OY_v	pitch axis
OZ_v	yaw axis (which is assumed to be in the local vertical plane).

Let OH be the satellite's kinetic moment; its direction is defined by the two angles εh and εv between OX_v and the projections of OH onto the planes $OX_v\ Y_v$ and $OX_v\ Z_v$.

3.4.2 Dispersions of the Europa I Vehicle at Injection

In view of the axis system chosen and the guidance mode (inertial) the dispersions at injection depend very little on the mission. Typical values (1 sigma) are given below :

$\Delta X = 0.5$ km $\Delta U = 1.3$ m.sec^{-1}

$\Delta Y = 1.9$ km $\Delta V = 5.6$ m.sec^{-1}

$\Delta Z = 0.9$ km $\Delta W = 3.3$ m.sec^{-1}

3.4.3 Dispersions of the Europa II Vehicle at Injection

The dispersions of position and velocity depend on :

a) the dispersions at 3rd stage cut-off;

b) the duration of the ballistic phase before ignition of the perigee motor (propagation of preceding errors);

c) the mechanical characteristics of the satellite (inertias and accuracy of assembly).

Therefore the dispersions at injection cannot be given once and for all. It may be assumed, however, that the perigee stage introduces only a dispersion of velocity. In the case of a typical geostationary mission, the anticipated dispersions are :

$\Delta U = 12.3$ m.sec^{-1} maximum value* 36.8 m.sec^{-1}

$\Delta V = 17.2$ m.sec^{-1} maximum value 43.6 m.sec^{-1}

$\Delta W = 12.7$ m.sec^{-1} maximum value 25.7 m.sec^{-1}

It may therefore be said that the dispersions of position at the injection of the Europa II vehicle result from the propagation during the ballistic phase of the errors of position given at 3.3.2 and that the errors of velocity (in a first approximation) are those resulting from the perigee motor.

For the same geostationary mission, the dispersions of the direction of the kinetic moment are :

$\delta h = 0.4^\circ$ maximum value* 1.0°

$\delta v = 0.3^\circ$ maximum value 0.6°

---

*These dispersions cannot be considered to follow a normal law. The maximum value given here corresponds to a probability equal to a deviation of 3 for a normal law.

3.5 Description of a typical mission

The mission chosen for reference purposes is a Europa II mission launched eastwards from Guiana with a circular parking orbit of 300 km altitude. The variation of certain significant parameters is shown in Figs. 3.8 to 3.12.

The launch azimuth is 91.6°. During the first 20 sec the vehicle follows a vertical trajectory then turns over at a rate of 0.7° per second until it reaches an angle of 21.8° to the launch horizontal. This attitude remains constant until the end of the 1st stage flight. During the flight of the other stages the vehicle is freed from aerodynamic constraints and follows an optimum turnover programme under the control of the guidance system.

Injection into 300/300 orbit takes place 665 sec after lift-off. The auxiliary attitude control system is then brought into play to orient accurately the combination of the 3rd stage, 4th stage and payload. The guidance system computes the instant at which the perigee motor must be ignited. For this mission, ignition must take place some 20 sec before passing the node. Before ignition, the combination of the perigee stage and payload is separated from the 3rd stage and then spun up. The perigee stage burns for 45 sec and a few seconds after its motor cut-off the payload is separated. The final orbit obtained has the following characteristics :

- perigee altitude	300 km
- apogee altitude	36,270 km
- argument of perigee	180°
- inclination	3.3°
- period	642 min

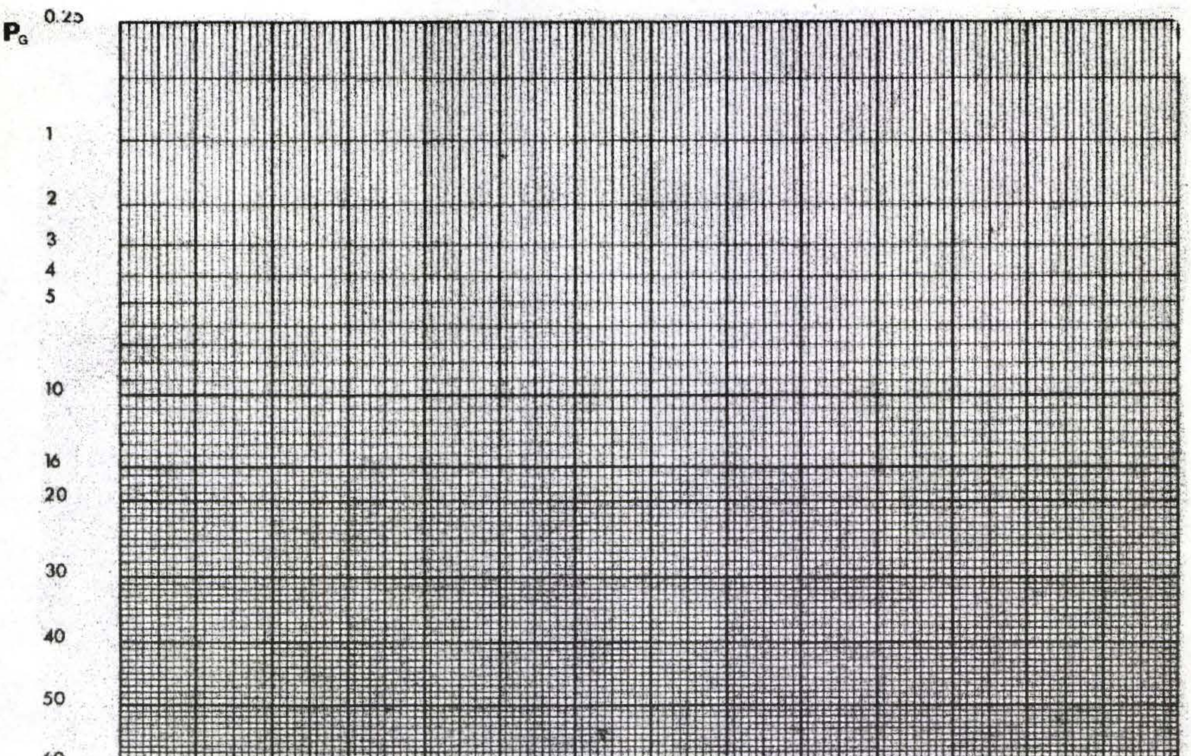

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Figure: 3.1

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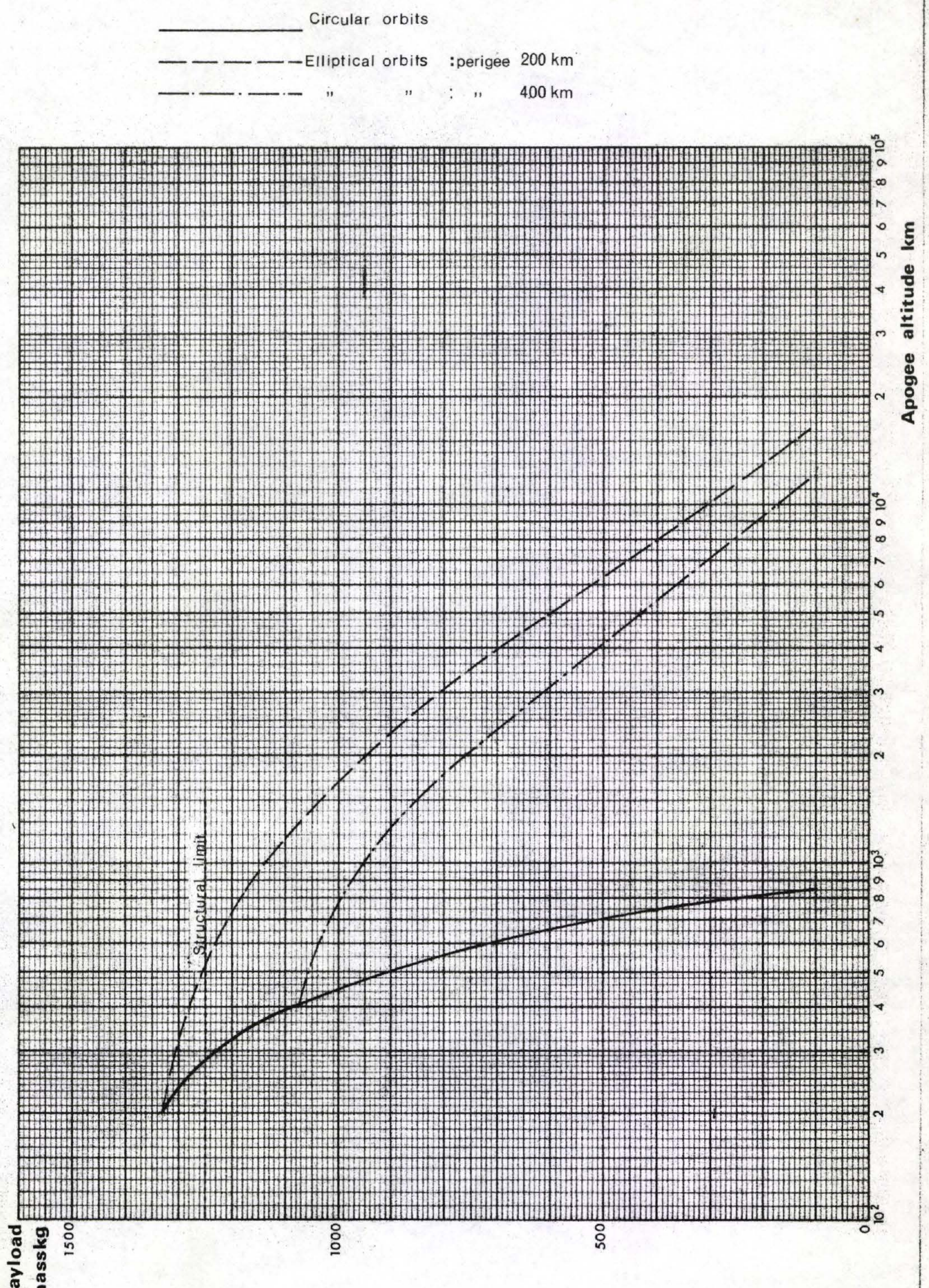

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EUROPA I

Guiana, easterly launches

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Figure: **3.2**

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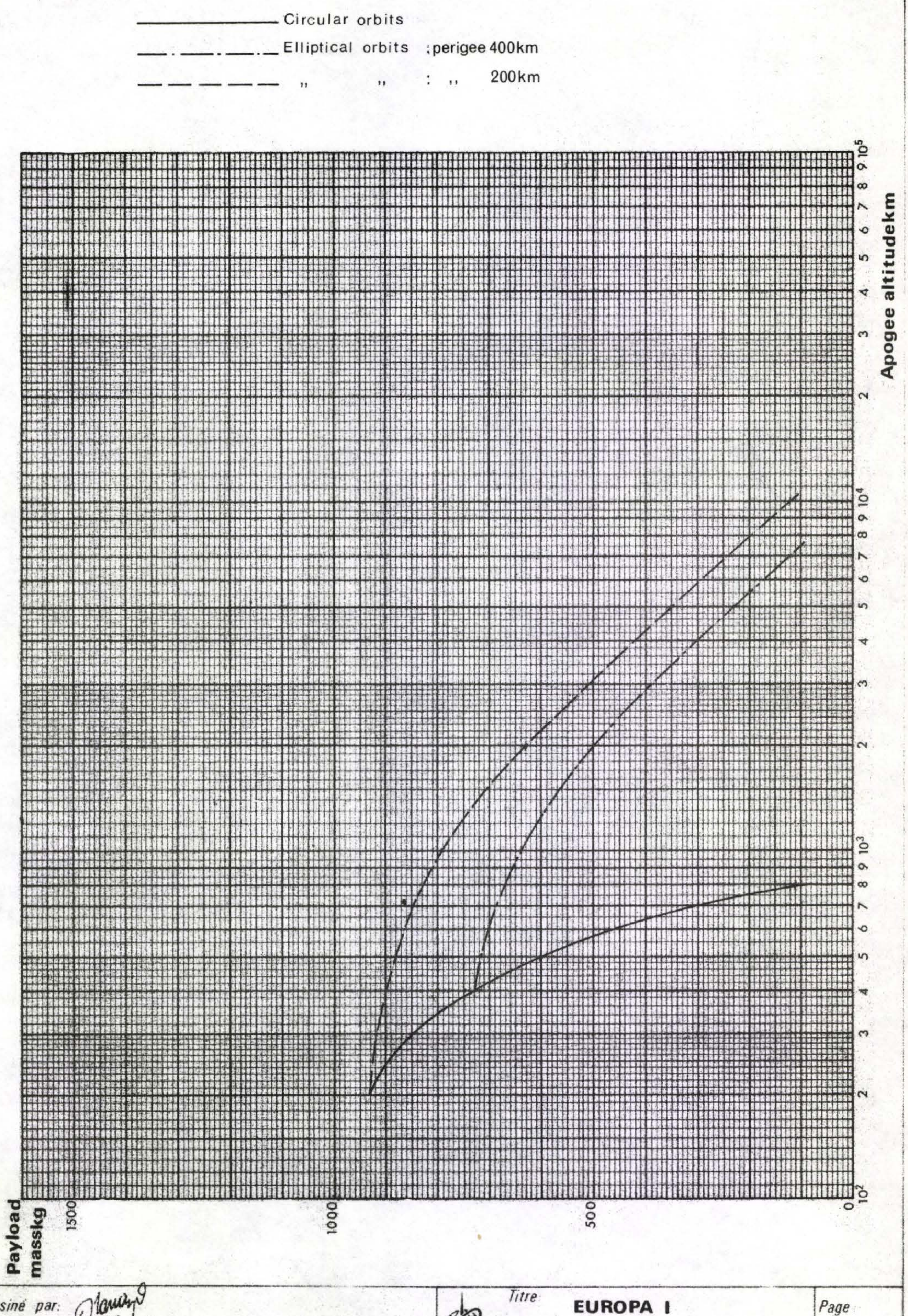

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EUROPA I

Guiana, northerly launches

Page
Figure: **3.3**
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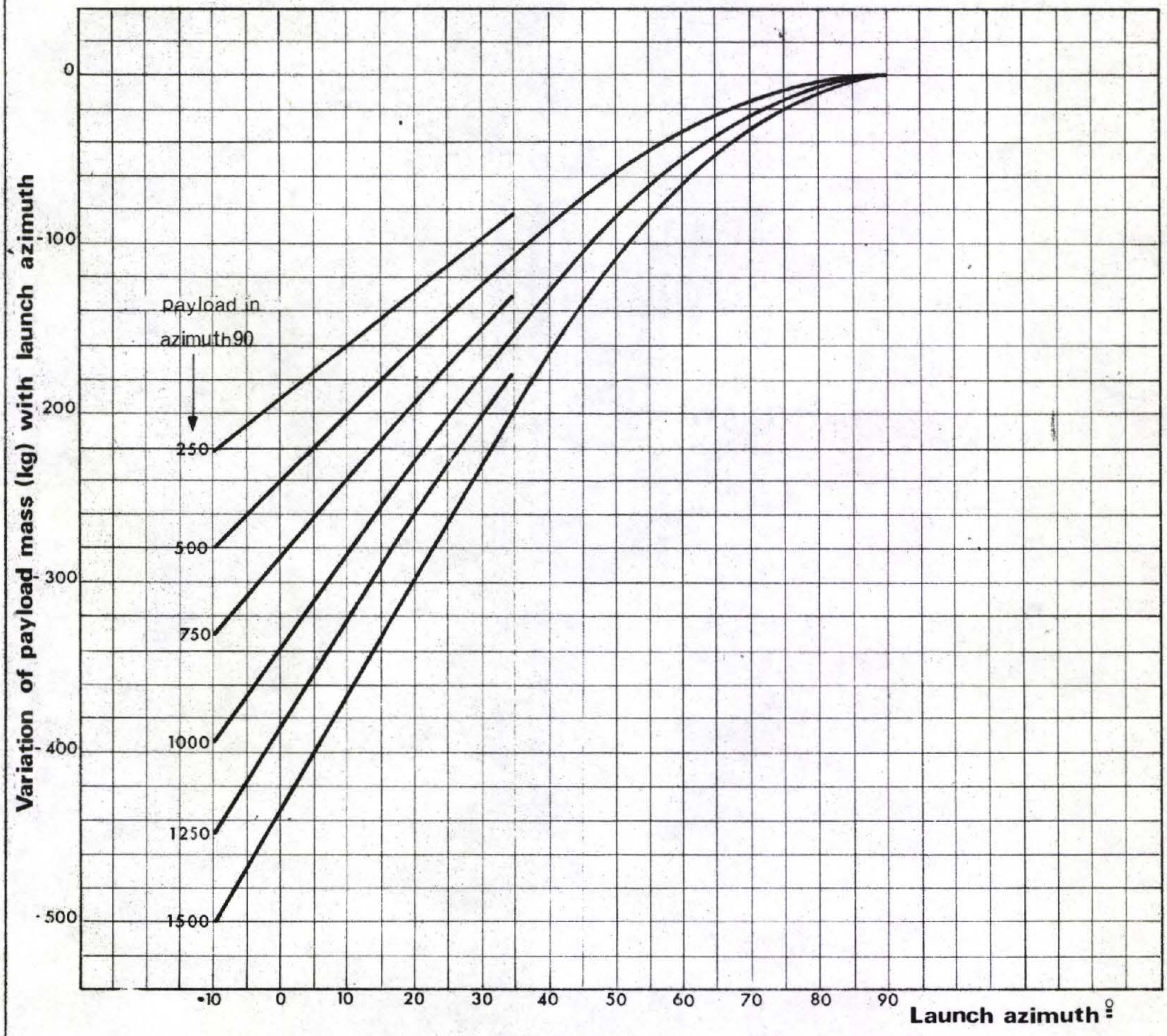

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Figure: 3.4
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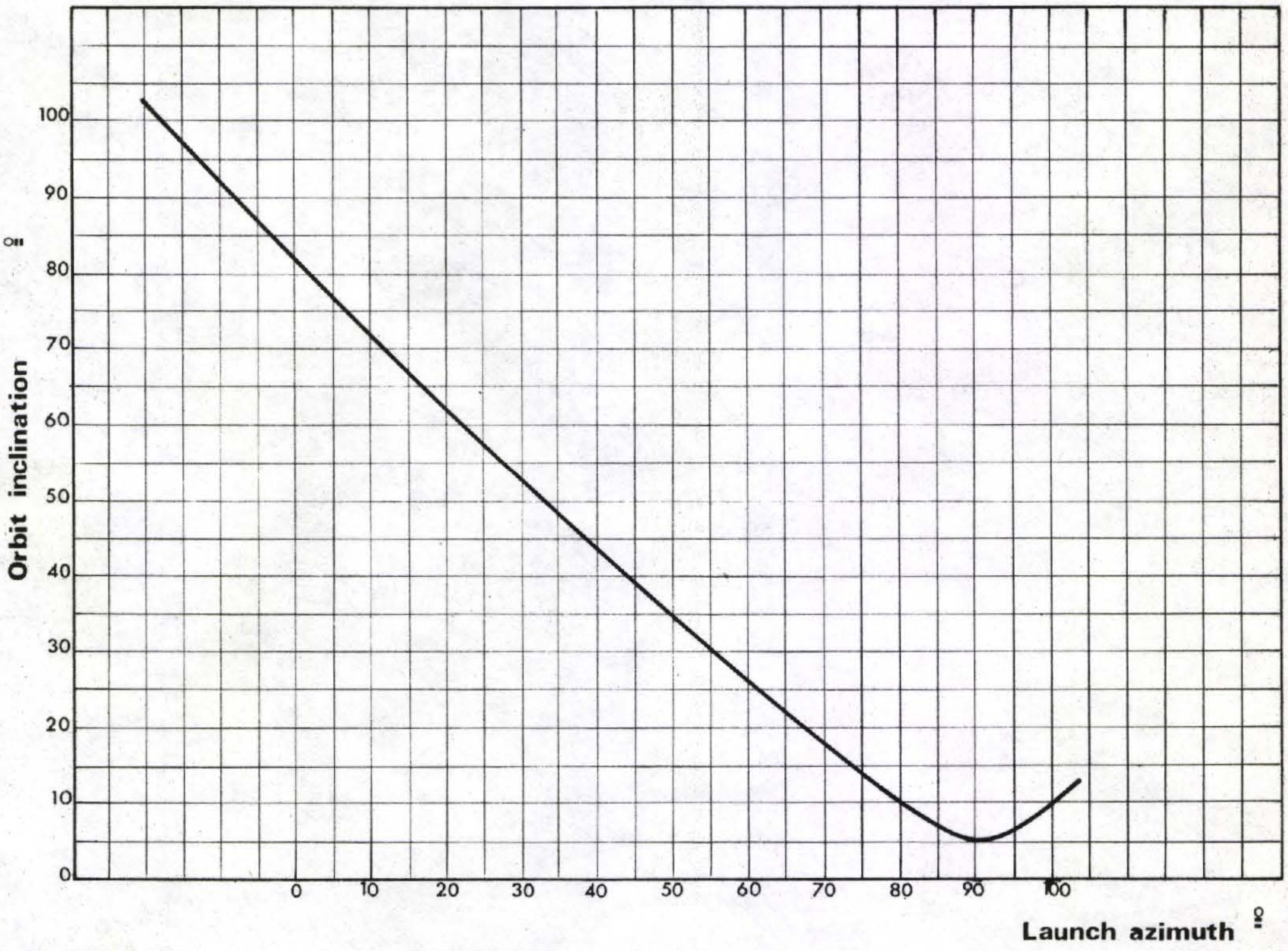

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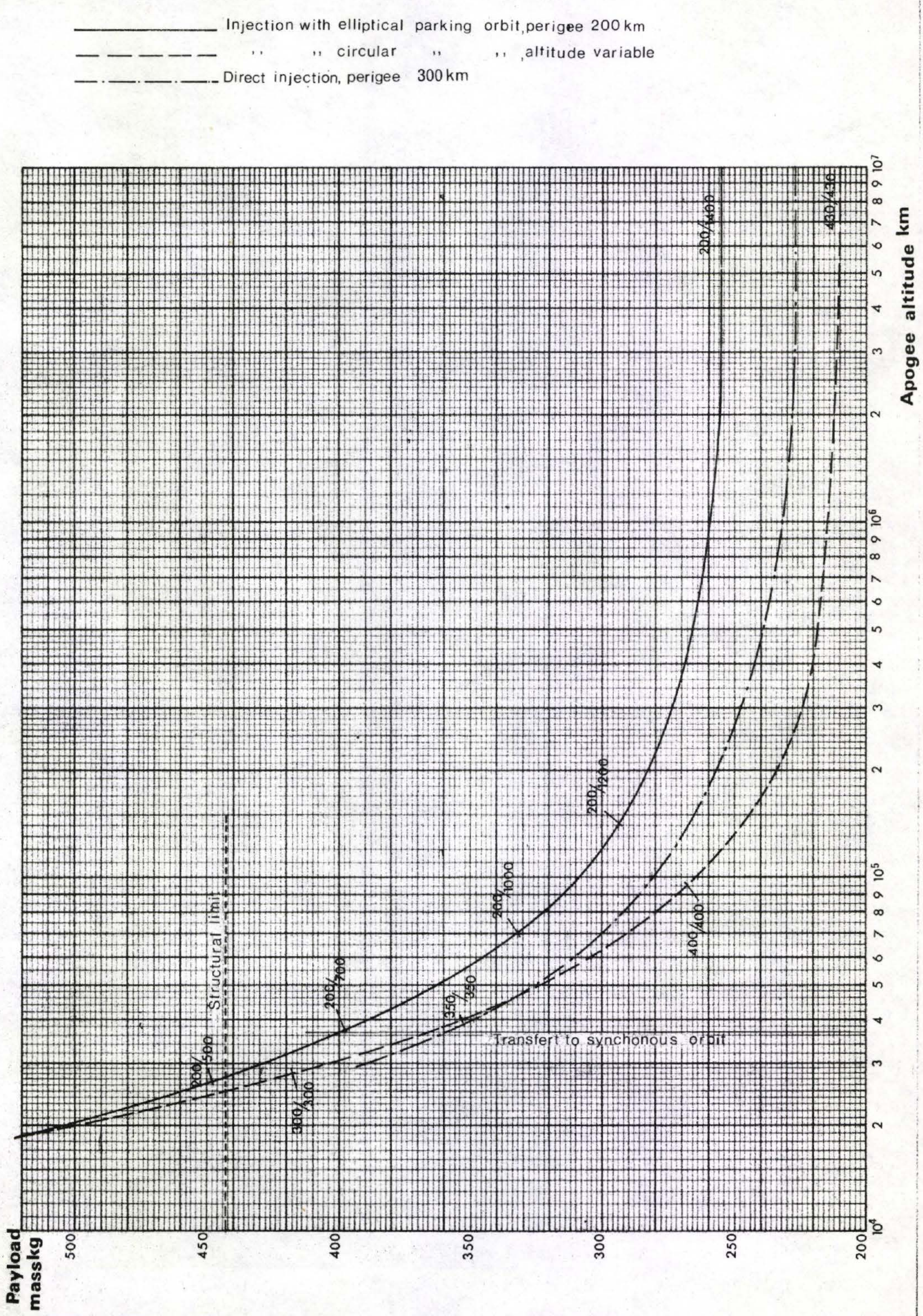

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Titre:

EUROPA 2

Guiana, easterly launches

Page

Figure 3.6

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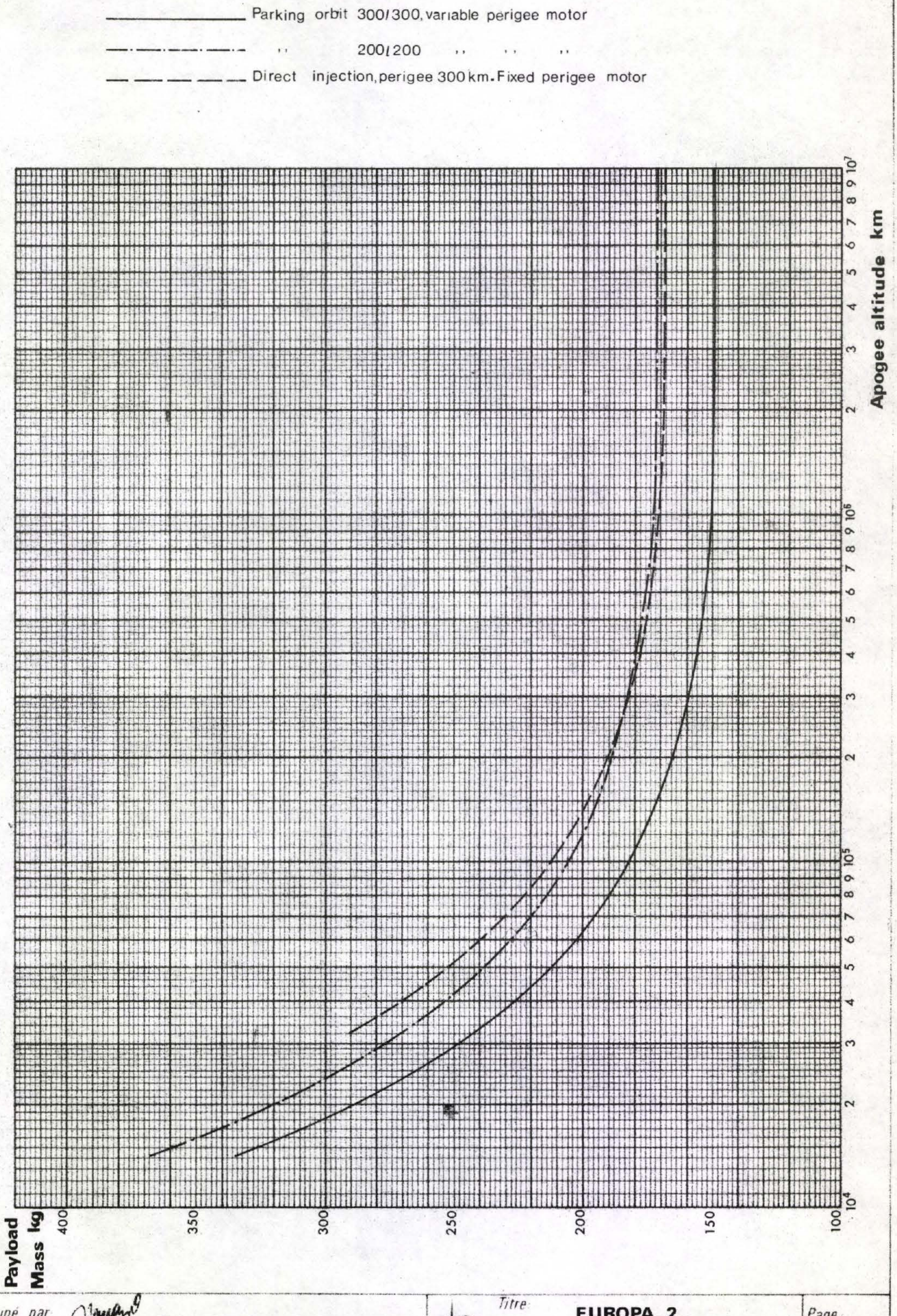

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EUROPA 2

Guiana, northerly launches

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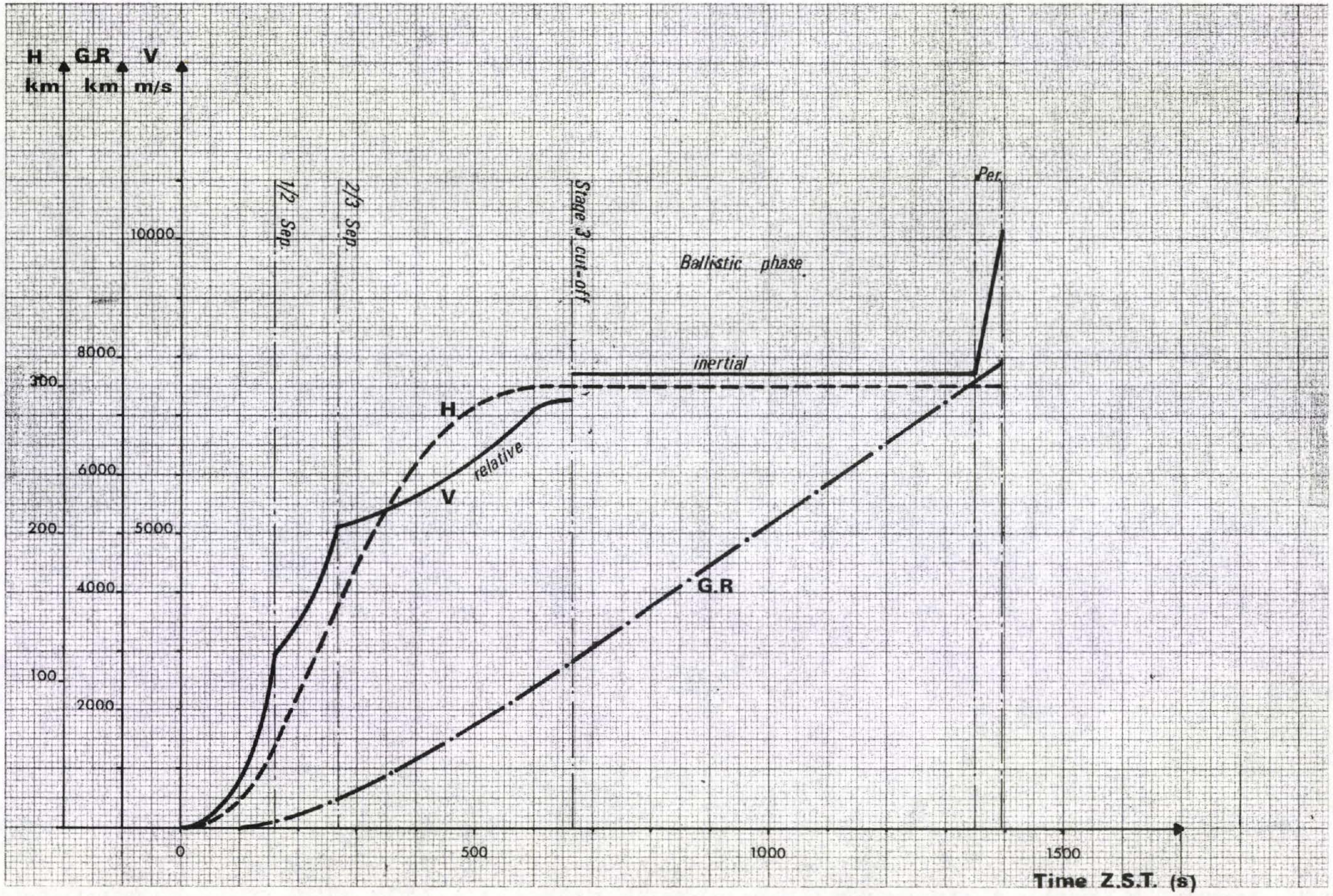
Figure: 3.7

AL.0



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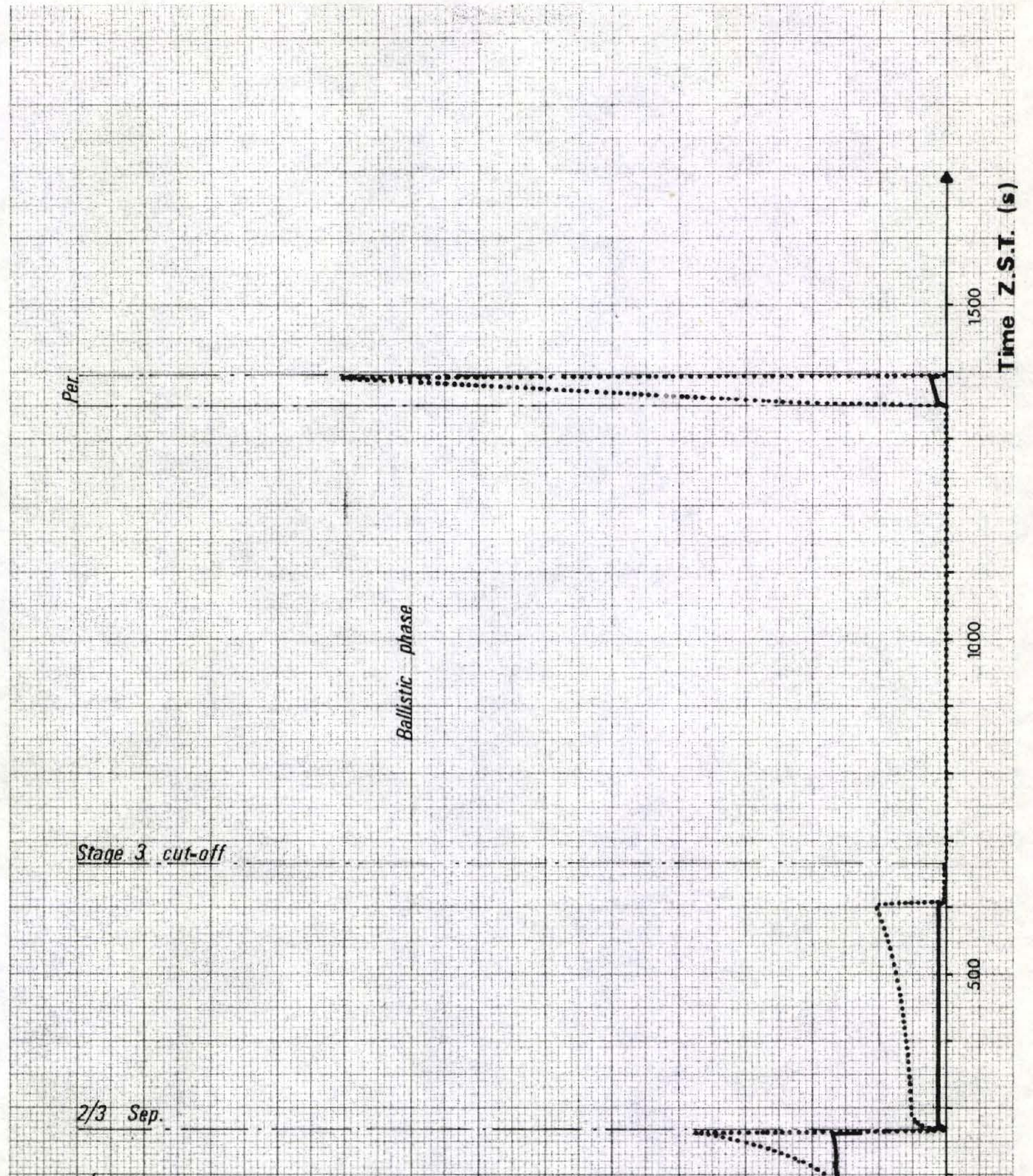
Titre: **EUROPA 2**
Altitude history: H
Ground Range history: G.R.
Velocity history: V

Page:
Figure: 3.8
AL.O



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Titre: **EUROPA 2**

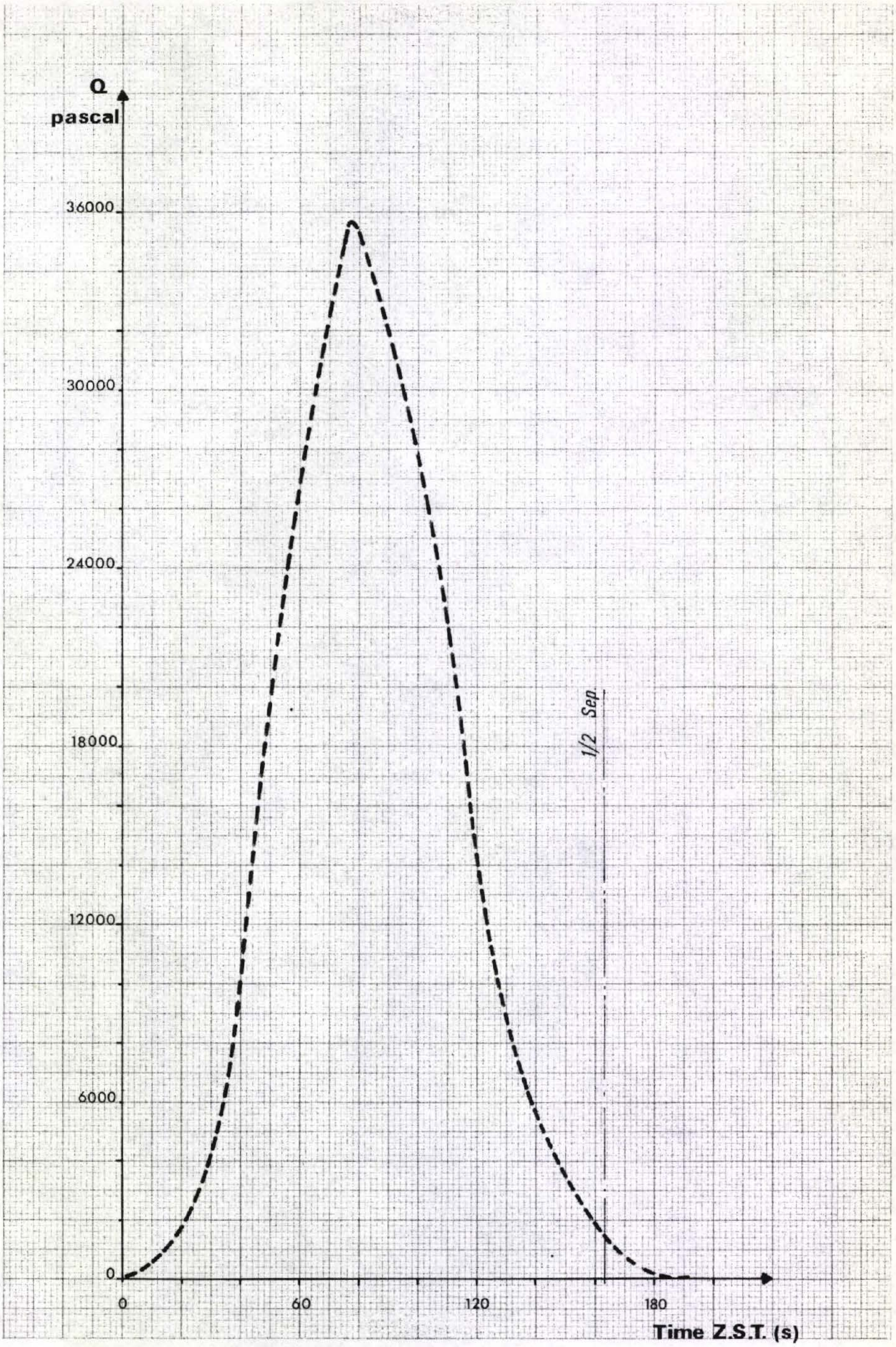
Longitudinal apparent acceleration history: A_1

Thrust history: P

Page:

Figure: 3.9

AL.O



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Titre: **EUROPA 2**
Dynamic pressure history

Page:
Figure: 3.10
AL.O

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① **1/2 stage separation**

t : 162.8 s
H : 59.5 km
G.R.: 117.5 km
V : 3016 m/s

② **Drop fairings**

t : 220 s
H : 108.3 km
G.R.: 302.6 km
V : 3863 m/s

③ **2/3 stage separation**

t : 268.5 s
H : 151 km
G.R.: 510 km
V : 5120 m/s

④ **Drop middle skirt**

t : 280.5 s
H : 162.2 km
G.R.: 567 km
V : 5150 m/s

⑤ **Injection into parking orbit**

t : 665 s
H : 300 km
G.R.: 2841 km
V : 7241 m/s

⑥ **Ignit. perigee stage**

t : 1350.4 s
H : 297.1 km
G.R.: 7583 km
V_{INER} : 7729 m/s

⑦ **Cut-off perigee stage**

t : 1395.4 s
H : 300.4 km
G.R.: 7938.8 km
V : 10161 m/s

⑧ **1ST stage impact**

t : 447 s
G.R.: 921 km

⑨ **Fairings impact**

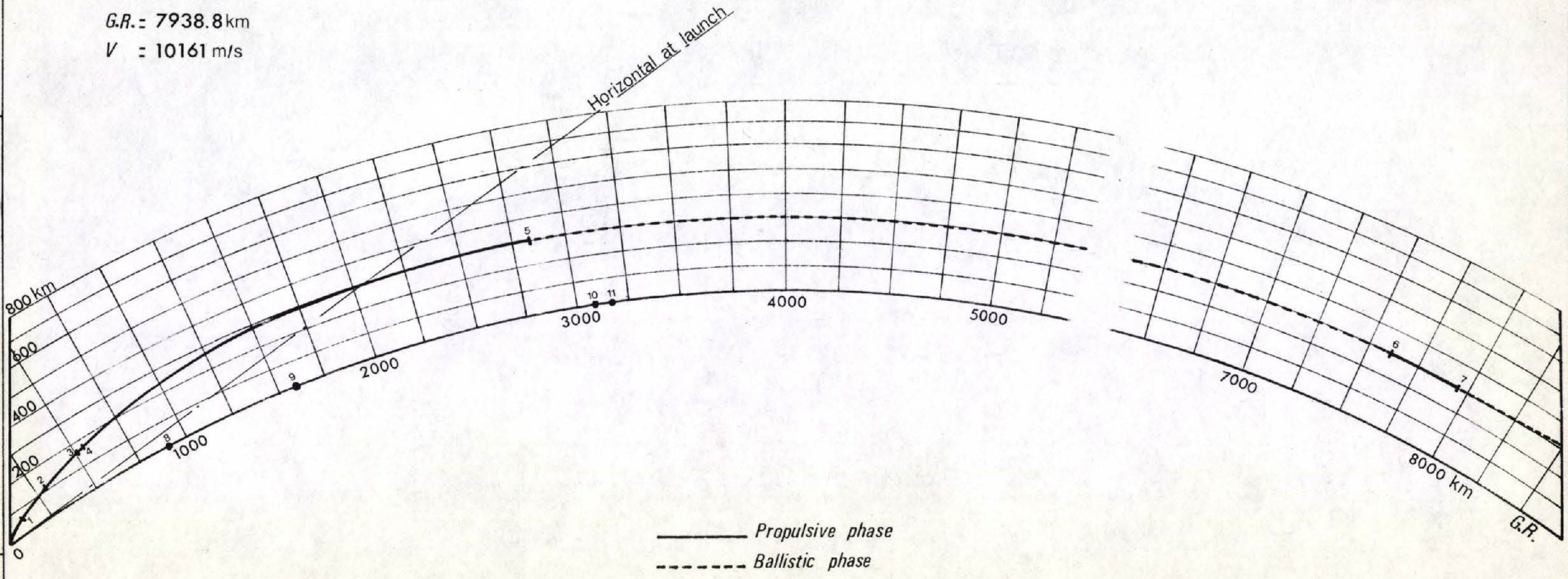
t : 566 s
G.R.: 1576 km

⑩ **2ND stage impact**

t : 798.8 s
G.R.: 3075 km

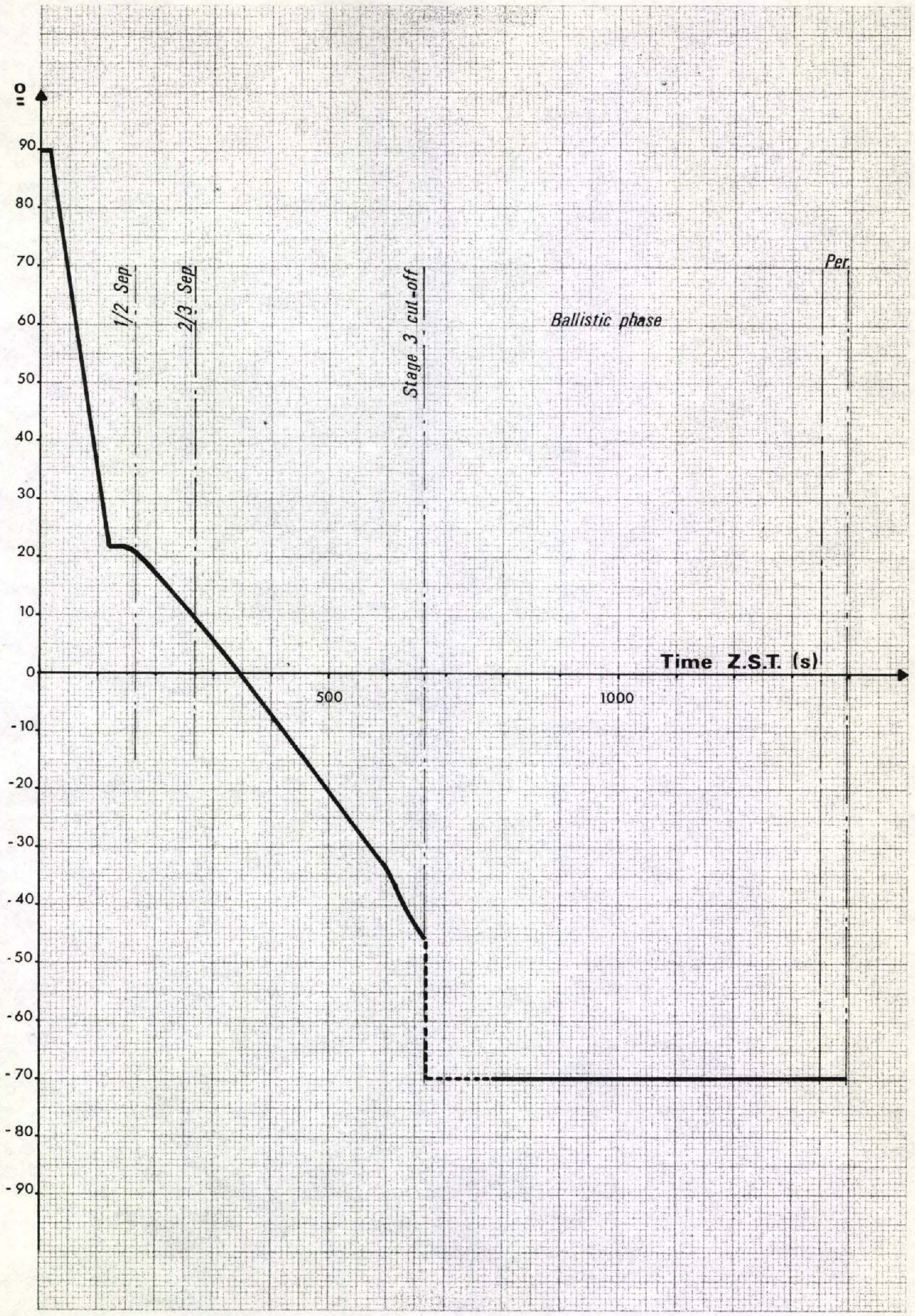
⑪ **Middle skirt impact**

t : 810.8 s
G.R.: 3163.5 km



Titre: **EUROPA 2**
F11 Trajectory

Page:
Figure: 3.11
AL.O



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Titre: **EUROPA 2**

Attitude hitory (?)

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Figure: 3.12

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4. SPACECRAFT LAUNCHER INTERFACES

4.1 Mechanical interface

4.2 Electrical interface

4.3 Fairings

4.4 Radioelectric interface

CHAPTER 4 - SPACECRAFT LAUNCHER INTERFACES

4.1 Mechanical Interfaces

4.1.1. Separation systems

Several attachment fittings have been developed and qualified during the development programme of Europa I and II. Although up to F9 no orbital separation has taken place, all the various systems for Europa I have been successfully flown.

In Europa I (three-stage vehicle) three different systems have been developed of 1100 mm, of 810 mm and of 650 mm diameter. The spacecraft separation is triggered by firing circuits in the 3rd stage which are in turn controlled by the 3rd stage sequencer.

In Europa II (four-stage vehicle) only one system has been developed of 650 mm diameter. The spacecraft separation is fired by the perigee stage sequencer.

The various systems, except the 1100 mm, have the same installation procedure : ELDO provides the complete spacecraft separation system, which is already installed on the upper stage before erection. The payload is then bolted on to the upper ring of the separation system when the erection of all stages is completed. A template of the upper ring or equivalent fixture is provided by ELDO to the spacecraft authority for manufacturing the payload connection plate in order to mate the upper separation ring.

For the installation of the 1100 mm separation system, it is necessary to define in each particular case the mounting tolerances, the rigidity specifications of the bottom, of the spacecraft, etc...., since these specifications depend on the weight and the position of the centre of gravity of the spacecraft. The eight pins which must be installed on the spacecraft are delivered to the spacecraft authority which is responsible for the installation under the prescribed tolerances. The spacecraft is erected and fastened with the Marman belt on top of the vehicle.

4.1.1.1 1100 mm separation system (available for Europa I only)

This system has been studied for mounting either directly on top of the 3rd stage or on the flat adapter (see para. 4.1.2.1)

The 1100 mm separation system has the general arrangement shown in Fig. 4.1; eight pins equally spaced on a circumference of 1100 mm are mounted at the bottom of the spacecraft. These pins mate with eight attachment points mounted on top of the 3rd stage. A Marman belt holds the pins together. This Marman belt is held in place at a predetermined tension by two explosive bolts. Once the bolts are exploded, eight springs horizontally mounted on the outer circumference corresponding with the pins and fastened to a frame which remains on the 3rd stage after separation, help the belt to clear the pins.

In Fig. 4.2, the dimensions of one of the pins which must be installed on the bottom of the spacecraft are given.

Eight springs installed in special pads in the pins then push the spacecraft away, causing physical separation. These springs are matched in order to minimise the spacecraft tumbling rate. Three types of springs (A, B or C type) can be provided in order to obtain different spacecraft velocities, with different spacecraft weights.

Provision is made so that the belt when expanded by the springs does not cross the payload separation plane.

The specifications of this separation system are :

- relative separation speed : 0.25 to 0.6 m/s } see fig. 4.3
- loading (for one spring) : 14 to 80 kg } see fig. 4.3
- separation useful stroke : 17.5 mm
- total weight : 7.1 kg (whose 1.3 kg remains on the spacecraft)
- maximum dynamic residuum : 0.01 rd/s
- forces at elasticity limit : compressive axial load 10,000 kg
  or
  moment = 2600 kg.m

The resulting range of mass and height of centre of gravity is given in fig. 4.13.

4.1.1.2 650 mm separation system (available for Europa I only)

This system, which is shown in fig. 4.4, has been studied in order to accomodate polyhedric spacecraft with a small base. Because of the small diameter, this system cannot be directly installed on top of the 3rd stage, and an intermediate adapter is necessary. Two types of adapter are possible : a flat adapter identical to that used with the 1100 mm separation system (see para. 4.1.2.1) or a tapered adapter (see para. 4.1.2.2).

The 650 mm separation system is made up of two mating rings held together before separation by 40 wedges. A steel belt stretched at a predetermined tension by two turnbuckles diametrically opposed holds the wedges in place. Its tension is equally distributed along the rings and is normal to the separation plane.

Separation is accomplished by firing two explosive bolts. The belt is then suddenly released and the stored elastic energy is sufficient for its jettisoning. The relative trajectory is given in Fig. 4.5. If required by the spacecraft shape, it is possible to retain the belt on the 3rd stage using an appropriate system of springs in order to avoid any risk of collision with the spacecraft.

As soon as the belt is released, eight helical springs placed in appropriate pads in the separation system lower ring push away the spacecraft causing physical separation. These springs are carefully matched to minimise the tumbling rate after separation.

Fig. 4.6 shows the upper ring of the separation system which must be bolted on the bottom of the spacecraft.

The specifications of this separation system are :

- relative separation speed : in the 1 m/s range } see remark
- loading (for one spring) : 33 kg } below
- separation useful stroke : 37 mm }
- total weight : 3.1 kg (whose 0.8 kg remains on the spacecraft)
- maximum dynamic residuum : 0.007 rd/s
- forces applied during static test : compressive load : 2750 kg

or

moment = 225 kg.m

The maximum admissible values of forces applied have not been measured. The admissible range of mass and height of centre of gravity is given in fig. 4.13. It can be seen that, even for accommodating the smallest Europa I payloads, additional testing with more severe values is necessary.

Remark : In order to match various weights and/or to obtain various separation velocities, spings having different characteristics can be provided on request.

4.1.1.3 810 mm separation system (available for Europa I only)

N.B. - This system is also used in Europa II, for the separation of the perigee stage from the 3rd stage.

The general arrangement of this system and the upper ring which must be bolted on the bottom of the spacecraft are shown in fig. 4.7 and 4.8. This system cannot be installed on top of the 3rd stage; it is integrated to the only adapter available, the lower skirt designed as the support of Europa II perigee stage (see para. 4.1.2.3).

The Marman belt is released by two actuators diametrically installed on the belt, operated by the ignition of a cartridge.

The initial movement of the payload with respect of the 3rd stage is caused by 8 springs contained within the belt assembly.

The specifications of the 810 mm separation system are :

- relative separation speed : 1 m/s (for an upper mass of 1150 kg and a lower mass of 865 kg)

- loading (for one spring):130 kg
- separation useful stroke :40 mm
- total weight - lower part and belt = part of the lower skirt
  - upper part remaining on the spacecraft : 1.1 kg
- maximum dynamic residuum : 0.02 rd/s
- forces applied during static test : compressive load 10650 kg
  and
  moment = 1190 kg.m

The maximum admissible values of forces applied have not been measured. The admissible range of mass and height of centre of gravity is given in Fig. 4.13. More severe values should require additional testing.

4.1.1.4 Perigee spacecraft 650 mm separation system (available for Europa II only)

This unit is presently being developed for the operational vehicle, and will be installed on top of the equipment bay (see para 4.1.2.4).

In principle, the same standard as that of F11 will be maintained. However, the number of springs and their loading will be modified and also the surface finish of the upper ring in order to improve the thermal balance of the satellite.

The separation system is shown in Fig. 4.9; it is made up of two rings held together by a Marman clamp. The upper ring remains on the spacecraft after separation.

At the end of the perigee motor burning phase, a signal is generated by the perigee sequencer which triggers two explosive actuators installed on opposite sides of the belt. The belt then opens, but remains on the equipment bay, and the separation is operated by the action of the springs. Provision is made in order to prevent the Marman belt entering into the authorised volume for the spacecraft.

The specifications of this 650 mm separation system are still not completely defined. The following values must be considered as provisional.

- relative separation speed	:	between 1 and 2 m/s (for an upper mass comprised of between 100 and 440 kg and a lower mass of 105 kg)
- loading (for one spring)	:	60 kg
- separation useful stroke	:	40 mm
- total weight	:	2.0 kg (of which 0.9 kg remains on the spacecraft)
- maximum dynamic residuum	:	0.03 rd/s
- forces applied during static test	:	compressive load = 3650 kg and moment = 240 kg.m

The maximum admissible values of forces applied have not been measured. The admissible range of mass and height of centre of gravity are given in Fig. 4.14.

4.1.2 Adapters

The adapters are intermediate frames mounted between the top of the vehicle (3rd stage in the case of Europa I and perigee stage in the case of Europa II) and the spacecraft, either to house equipment or to provide a matching frame between the attachment points of the upper stage and the smaller diameter of the separation systems.

Although the set of units which is described in the following has been envisaged during the development programme to meet special requirements, these units, which are fully qualified, can now be offered to the customer as options in case of particular requirements without the need to develop new items.

4.1.2.1 Flat adapter (available for Europa I only)

This type of adapter is shown in Fig. 4.10 and was used for the F7 and F8 flights. The inside volume available for the installation of equipments is shaped like a cylinder of approximately 650 mm diameter and 210 mm height. Requirements for balance, mass distribution, Moment of Inertia, etc... of this equipment have to be negotiated with ELDO.

This adapter has been designed to be equipped with a 1100 mm separation system on the bottom and either a 1100 mm or a 650 mm separation system on the top.

This gives the possibility, if required, of separating first the payload adapter assembly from the 3rd stage and then the adapter from the payload. In this case additional separation circuits already developed for the Europa I programme must be installed in the adapter.

The structural capability is limited only by the separation system(s) used.

The weight (empty structure) is 15 kg.

4.1.2.2 Tapered adapter (available for Europa I only)

This adapter has been developed to match, during the F9 flight, the 650 mm separation system to the 3rd stage. The configuration is given in Fig. 4.11. Two end rings of different diameters are held together by a set of longitudinal stringers. The resulting tapered frame is welded along its side to a skin 1 mm thick to absorb the shear stress.

A volume having the shape of a cylinder of approximately 650 mm diameter and 200 mm height is available inside the adapter for installation of equipment as required. Requirements for balance, mass, moment of inertia, etc. of this equipment have to be negotiated with ELDO.

The structural capability is tested together with the 650 mm separation system (see para. 4.1.1.2).

The weight (empty structure) is 15 kg.

4.1.2.3 Lower skirt (available for Europa I only)

N.B. - This system is also used in Europa II, as a support for the perigee stage.

The general arrangement can be found in fig. 4.12 and the description under para. 2.2.4a.

The structural capability is tested together with the 810 mm separation system (see § 4.1.1.3).

The weight(empty structure)including the 810 mm separation system is 15.8 kg.

4.1.2.4 Equipment bay (available for Europa II only)

This unit is presently being developed for the operational vehicle. It will be installed on the top of the perigee stage for installation of monitoring equipment and for eventual additional equipment requested by the spacecraft authority.

The height of this unit including the separation system will not be higher than 250 mm (between planes N° 7 and N° 9).

The weight will be about 25 kg.

The structural capability will be limited only by the perigee spacecraft + 650 mm separation system (para. 4.1.1.4).

The equipment bay has been designed so that an eventual increase of diameter of the separation system will require only modifications of the skin of the equipment bay without requiring a complete reallocation of equipment.

4.1.3 Mechanical requirements

4.1.3.1 Europa I

The total spacecraft weight including the part of the separation mechanism which remains with the satellite after separation must be kept within ± 5 kg with respect to the value declared by the customer in the document "Launch request".

The sum of the above mass and of the adaptors must be comprised between 300 and 1250 kg (see fig. 4.13).

The centre of gravity of the spacecraft must not fall more than 10 mm away from the geometrical axis defined by the vertical to the centre of the mounting ring, and it must be comprised between 400 and 1650 mm above plane No. 3 (spacecraft or adaptor mounting plane ; see fig. 4.21).

4.1.3.2 Europa II

The total spacecraft weight, including the part of the separation mechanism which remains with the satellite after separation must be kept within ± 2 kg with respect to the value declared by the customer in the document "Launch request".

This mass must be comprised between 100 and 440 kg (see fig. 4.14).

The centre of gravity of the satellite must not lie more than 1 mm away from the geometrical axis defined by the vertical to the centre of the mounting ring, and the angle between the geometrical axis and the inertial axis must not exceed 0.1°. It must be comprised between 200 and 850 mm above plane N° 9 (satellite mounting plane; see fig. 4.22).

The nominal spin rate of the 4th stage around the X axis is 120 rpm; this value can be varied on request by a variation of the number of spinning rockets (2,3 or 4), of the quantity of propellant and of the length of the arms (see fig. 4.15). However below 90 rpm the angular errors become important; and the perigee motor is not qualified above 180 rpm. The range of spin rate is given in fig. 4.16 versus the roll moment of inertia of the spacecraft.

4.2 Electrical Interfaces

4.2.1 Umbilical connections

4.2.1.1 Europa I

Europa I umbilical connections are of 2 possible types :

a) Identical to Europa II umbilical solution (see para. 4.2.1.2) with an internal umbilical arm. This solution is more flexible as far as the location of the umbilical plug on the spacecraft is concerned.

b) Installation of the umbilical plug (Souriau type 8912-01/02) at the fairing wall level with an arm supporting both the plug and the cable loom between the plug and the spacecraft. Access to the plug through the fairings is by a clip door. Such a solution has been used during the development programme with the flat adapter (see fig. 4.17). In this case an explosive umbilical connector is required between the spacecraft and the adapter at the separation plane. The firing circuits of the spacecraft separation system, located in this case in the 3rd stage, have to be modified.

Constraints on location of the umbilical plugs (internal and external) are defined in fig. 4.21.

4.2.1.2 Europa II

4.2.1.2.1 System description

An umbilical connection is provided between the spacecraft and the ground equipment. This connection is made up of the following parts :

- A socket of a push-pull connector installed on the spacecraft side wall near the Y axis (see Fig. 4.18) type Deutsch DS XX-61-5S-YYY (XX means 00 or 04 and YYY means 059 or 081). Constraints on location of this plug are defined in Fig. 4.22.

  This connector can be provided with 61 pins size 20 but coaxial connections are available on request by reducing the number of pins, e.g. for F11 the connector has been provided with 49 pins size 20 and 2 coaxial connections. It is the responsibility of the customer to provide the socket while the mating plug, type DS 07-61-5P-059, will be provided by ELDO according to the customers specifications.

- An internal umbilical cable between the spacecraft and the umbilical plug on the fairings. The internal disconnection of this plug is operated by means of a lanyard connected to a quick release pin which maintains in a horizontal position the support arm of the internal umbilical cable. When the pin is released, the push-pull connector is first disconnected by a lanyard with a force of 40 kg, then the support arm is withdrawn in a vertical position and locked in this position (see Fig. 4.18).

  In case of failure of this disconnect system, the push-pull connector will disconnect anyway at the time of jettisoning of fairings.

  Both the cable and the terminal plug will be procured by ELDO in agreement with the customer specifications.

- An umbilical connector is located on the fairing structure, Souriau type 8912-01/02, with a total capacity of 200 contacts size 20 and 4 coaxial connections. This connector is electrically operated from the ground, but a back-up mechanical disconnect operated by a lanyard is also provided. In the same housing of the connector but electrically separated, two connections are provided : one towards the spacecraft and the other towards the perigee stage. For F11, 100 pins and 2 coaxial connections are available for the spacecraft, but in fact the number of umbilical connections is limited by the capacity of the internal push-pull connector (49 pins + 2 coaxial connections, or 61 pins). Different arrangements for the spacecraft are available on request.

- An external umbilical cable between the fairings and the umbilical mast.

- A junction box at the top of the umbilical mast which is procured by CNES.

4.2.1.2.2 Umbilical ejection sequence

The umbilical ejection sequence in F11 is as follows :

- Ejection, in positive time, of the external umbilical cable

- Ejection of the satellite and perigee internal umbilical plugs after the external umbilical plug. Monitoring of the ejection of the internal plugs is carried out by the capsule and equipment bay telemetry systems (link on the free portion of the capsule and perigee internal umbilical plugs).

- The nominal ejection sequence is shown in fig. 4.19.

4.2.2. Grounding

Electrical grounding is provided on the vehicle, so that the electrical resistance between the upper separation ring and the ground is less than or equal to 0.2 ohm. It is the responsibility of the customer to ensure a proper electrical continuity between the upper separation ring and the spacecraft.

4.2.3. Spacecraft separation switch (Europa II)

A set of 4 separation switches can be made available on request for customer's use on the upper part of the satellite mounting frame.

These switches can be used to start the internal spacecraft programmes, to inhibit hazardous event up to spacecraft separation etc.....

4.3 Fairings

4.3.1 Description

The external shape is a cylinder having a diameter of 2 m faired to a 40° cone with a blunted nose. The overall length is 4.30 m. The fairings are made of two halves of heat resistant phenolic fibreglass sandwich with a honeycomb core of the same material. Different thicknesses of the walls have been used along the length in order to maintain as far as possible a uniform temperature on the inside skin.

A protective coating of ablative material is used to maintain the external temperature within acceptable limits. The thickness of this coating can be adjusted to meet the flight plan constraints.

A modification by extending the length of the fairings up to about 5.50 m is feasible and can be considered upon special request.

The two halves of the fairings are fastened together and to the top of the 3rd stage by means of a shaped ring tightened by two explosive bolts.

Four ballistic actuators, installed as indicated in Fig. 4.20, hold together the two half fairings.

The fairings are jettisoned during the propulsive flight of the 2nd stage : two electric pulses spaced 0.1 sec in time trigger first the explosive bolts and then ignite the ballistic actuactors which push aside the fairings , imparting sufficient velocity to avoid any risk of collision with the stallite and the vehicle. In order to avoid pollution of the spacecraft, the actuators are airtight.

An explosive connector, blown by the closure of a microswitch installed on the fairing edge, connects the pick-offs installed on the fairings to the telemetry system and the power lines to the pyrotechnic devices of the separation system.

4.3.2 Available Volume

4.3.2.1 Elements considered for the determination of the available volume

The volume available for the spacecraft has been defined taking into account the reduction due to :

a) The dynamic envelope of the fairings themselves,

b) The displacement of the perigee stage (Europa II),

c) The relative rotation of the fairing mounting plane and perigee stage (Europa II) mounting plane under flight loads,

d) The deformation of the 3rd stage main support,

e) Manufacturing tolerances,

f) The kinematic envelope of the fairings during separation,

g) Equipment and cabling installed on the internal skin of the fairings.

4.3.2.2 Hypotheses utilised

a) For Europa II a completely rigid payload with a maximum mass of 440 kg and c.g. position at 850 mm above plane No 9 has been considered. For Europa I these values correspond to a mass of 1250 kg with a c.g. at 1650 mm above mounting plane No 3 (actual structural limitations of the 3rd stage).

b) For Europa II the operational perigee stage is conforms to the "Clauses Techniques" E 25/0 of 19.11.70. The equipment bay of this stage of 250 mm height has been considered with the same mechanical characteristics as the F11 standard equipment bay of 443 mm height.

c) The following loads have been used to define the reduction of the volume :

- a lateral steady acceleration of 1.5 g to simulate the aerodynamic forces (lateral reduction of the volume)
- a longitudinal force of 7,000 kg applied on the fairings to simulate the aerodynamic forces (longitudinal reduction of the volume)
- a longitudinal acceleration of the vehicule of 2,5 g (kinematic envelope of the fairings at separation)
- a minimum lateral velocity of the fairings at separation of 3.1 m/s (flight measurements are 5.5 to 6 m/s).

4.3.2.3 Results

- Fig. 4.21 shows the volume available for Europa I payloads
- Fig. 4.22 shows the volume available for Europa II payloads.

4.3.3 Access doors and cooling air system

Four access doors of 150 x 300 mm are available. Two are on the Y half fairing and the other two at 180° opposite on the Y_N half fairing (see fig. 4.23 and fig. 4.24)

However, the location can be changed on request, and Fig. 4.25 shows the permissible areas for doors in the fairing structure. Attention is drawn to the fact that, if more access doors or even doors of greater dimensions are required, this would involve the following :

- further manufacturing tooling
- verification of the structural integrity.

The cooling air inside the fairing envelope is provided through a pipe installed on the 3rd stage diaphragm. The maximum air flow is 250 kg/H with the following characteristics : a temperature ranging from 8° to 13° C, less than 1 g/kg or humidity and 98 % of the particles larger than 15μ filtered.

The air entering the fairing envelope from the 3rd stage is collected in a longitudinal duct inside the fairing structure and horizontally deflected, parallel to the fairing wall.

The nominal exit speed from the duct is 6.3 m/s and an output venting door is provided near the bottom of the fairings for the hot air. Fig. 4.26 shows the cooling air arrangement inside the fairings. This arrangement may be modified on request.

4.3.4 Trajectory

The jettisoning system of the fairings has been designed to push the fairings parallel to the original position with a lateral velocity of 5.5 to 6 m/s (flight results). It must be noted that the motion of the fairings relative to the vehicle mainly depends on two factors : the apparent longitudinal acceleration and the jettisoning altitude.

In fig. 4.27 the fairing trajectory corresponding to a lateral velocity of 5.5 m/s (flight results) and an apparent longitudinal acceleration of the vehicle of 25 m/s^2 is shown.

4.3.5 RF Transparency

The following table shows the RF transparency of the fairings :

Temperature	Dielectric Constant		Loss angle (rad.)	
	10 MHz	8500 MHz	10 MHz	8500 MHz
Ambient temperature				
Perpendicular to lamination	4.99	4.89	0.031	0.051
Parallel to lamination	5.12	5.01	0.030	0.042
288°C (1/2 hour)				
Perpendicular to lamination	5.19	4.65	0.019	0.028
Parallel to lamination	4.97	4.85	0.011	0.017
315°C (1/2 hour)				
Perpendicular to lamination	5.17	4.39	0.019	0.027
Parallel to lamination	4.94	4.79	0.010	0.017

4.4 Radioelectric interfaces

4.4.1 Transmitters

The different transmitters used in the operational Europa I and II launchers have the following radioelectric specifications :

4.4.1.1 First stage telemetry

- Type = Mk II (manufactured by PTI)
- Number = 1
- Frequency = 241 MHz
- Transmitted power = 5 W
- Modulation = PCM/PM + FM
- Modulation bandwidth = 500 kHz

4.4.1.2 Second stage telemetry

- Type = Ajax (manufactured by SNIAS)
- Number = 1
- Frequency = 234,4 MHz
- Transmitted power = 15 W
- Modulation = PAM/FM/PM
- Modulation bandwidth = 500 kHz

4.4.1.3 Third stage telemetry

- Type = Mk II (manufactured by PTI)
- Number = 1
- Frequency = 137,6 MHz
- Transmitted power = 5 W
- Modulation = PCM/PM + FM
- Modulation bandwidth = 500 kHz

4.4.1.4 Perigee stage telemetry

- Type = TME 205 (SNIAS)
- Number = 1
- Frequency = 136,8 MHz
- Transmitted power = 1 W
- Modulation = PCM/PM
- Modulation bandwidth = 100 kHz.

4.4.2 Transponders

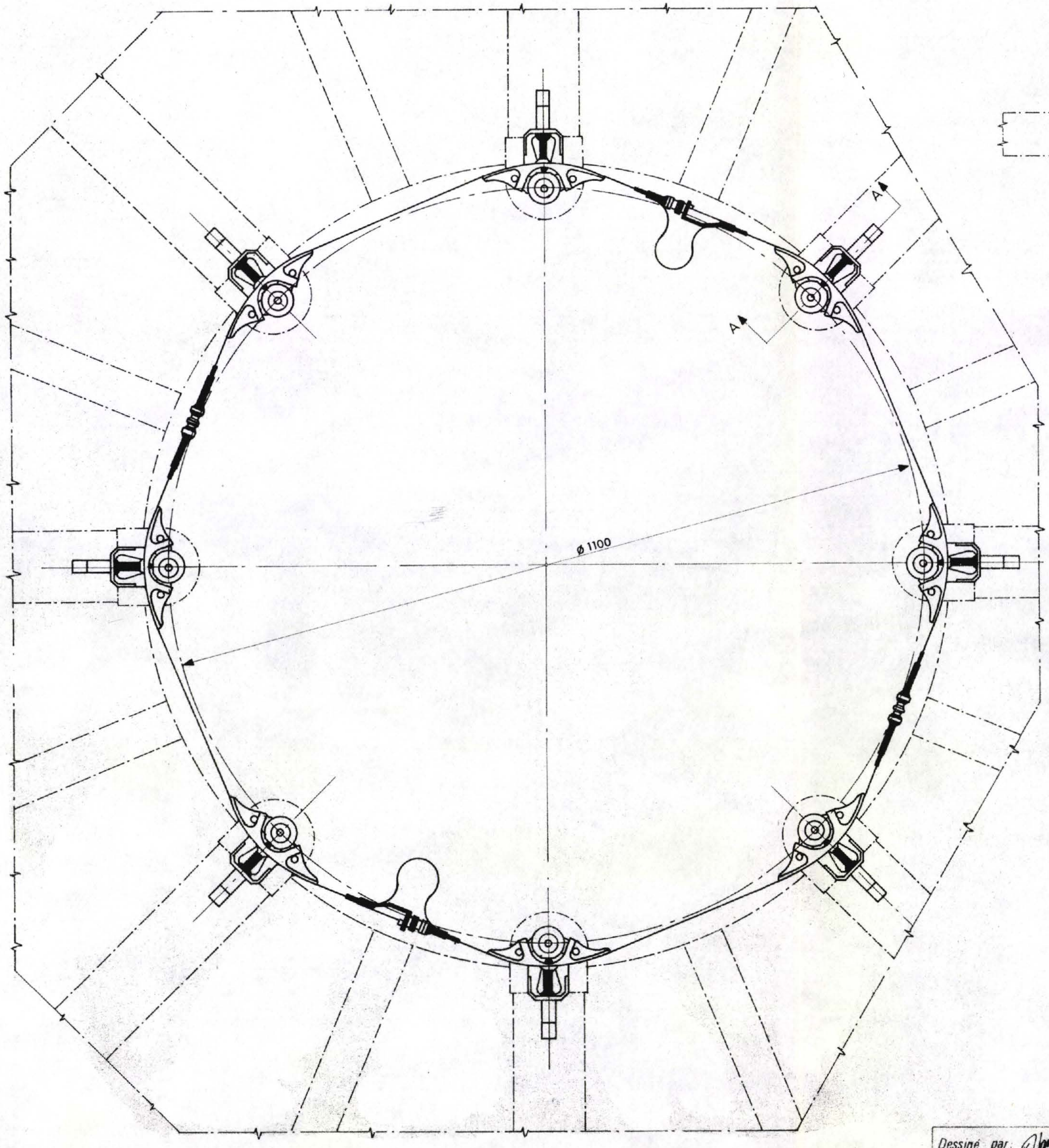
Two radar transponders are installed in the second stage for localisation purposes from Kourou. They have the following specifications :

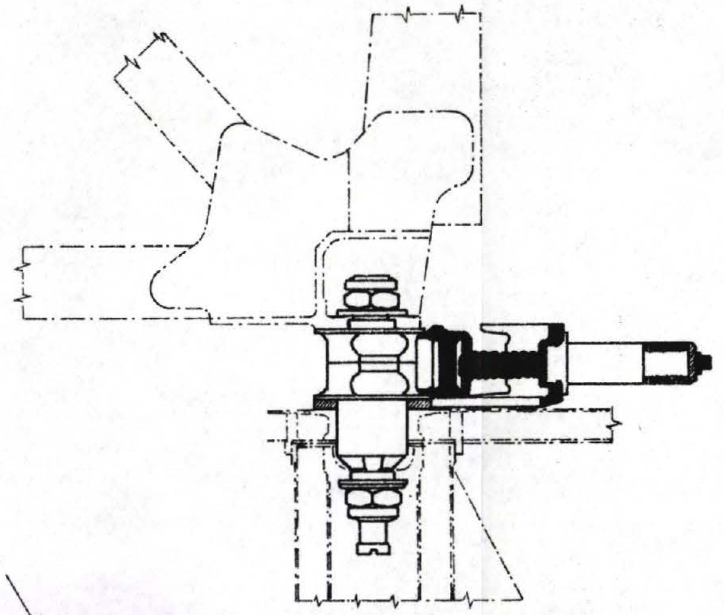
- Type = SST-171 C (manufactured by Motorola)
- Number = 2
- Receiving frequency = 5600 MHz
- Transmitted frequency = 5500 MHz for transp^{r} No 1
  = 5700 MHz " " " 2
- Transmitted power = 400 W (peak)
- Duration of transmitted pulses = 0.8 µs
- Interval between pulses = 3 x 585 Hz (sequential interrogation by 3 radars)
- Code = simple impulse
- Sensitivity at reception = - 100 dBW
- Rejection at reception = 60 dB on image frequency and 80 dB minimum between 0.15 and 10 000 MHz.

4.4.3 Receivers

Two receivers for telecommand of destruction are installed in the second stage. They have the following specifications :

- Type = manufactured by CNES
- Number = 2
- Frequency = 434 MHz
- Sensitivity at 434 MHz = - 123 dBW
- Total bandwidth = 0.5 MHz at - 6 dB
  1.5 MHz at -60 dB.





Section AA

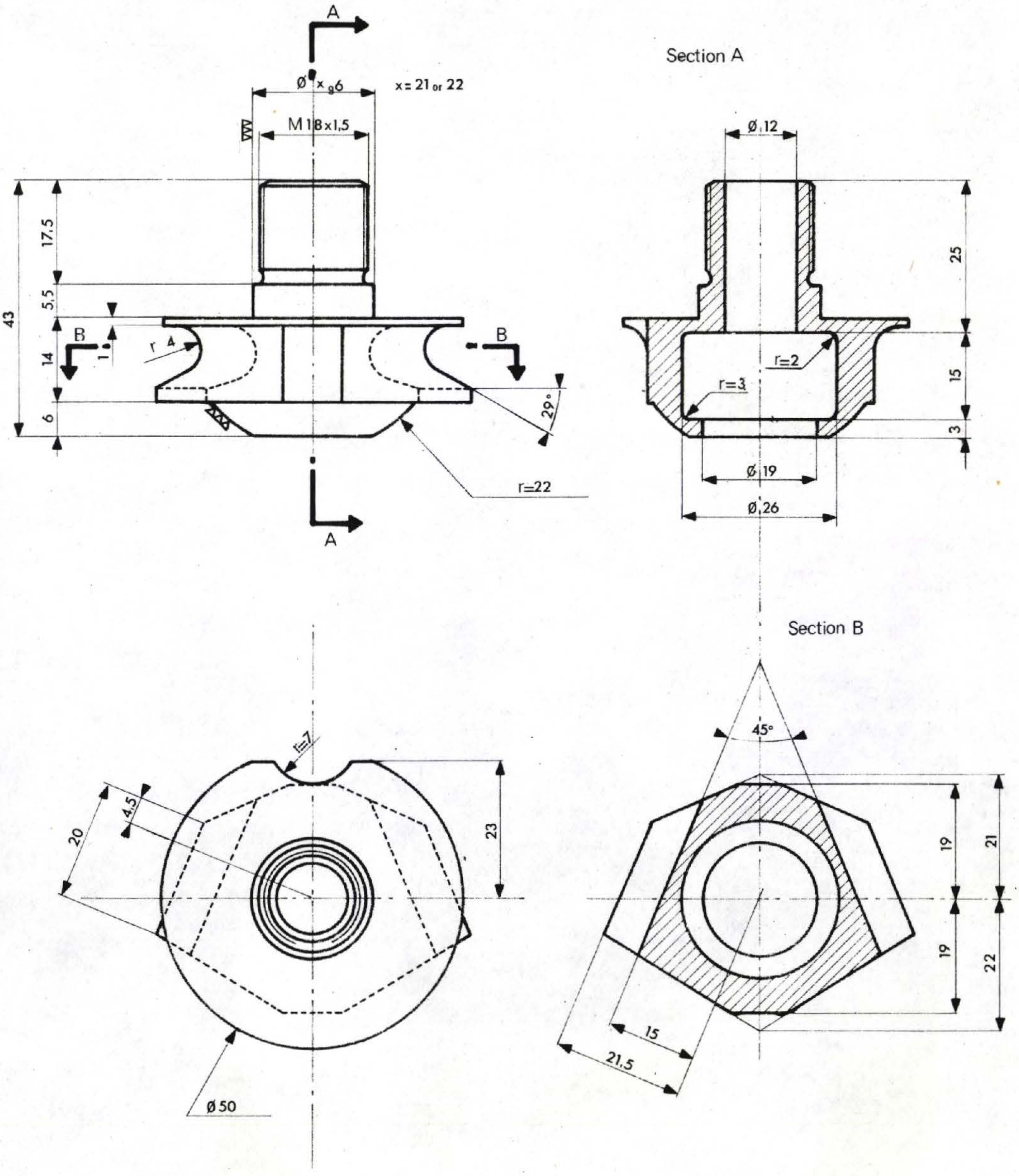
Dessiné par:
Vérifié par:

Titre:

EUROPA I

1100mm separation system

Page:
Figure 4.1
AL.0



Material : 19CN5 UNI 2953

Dessiné par: Glomazo
Vérifié par:

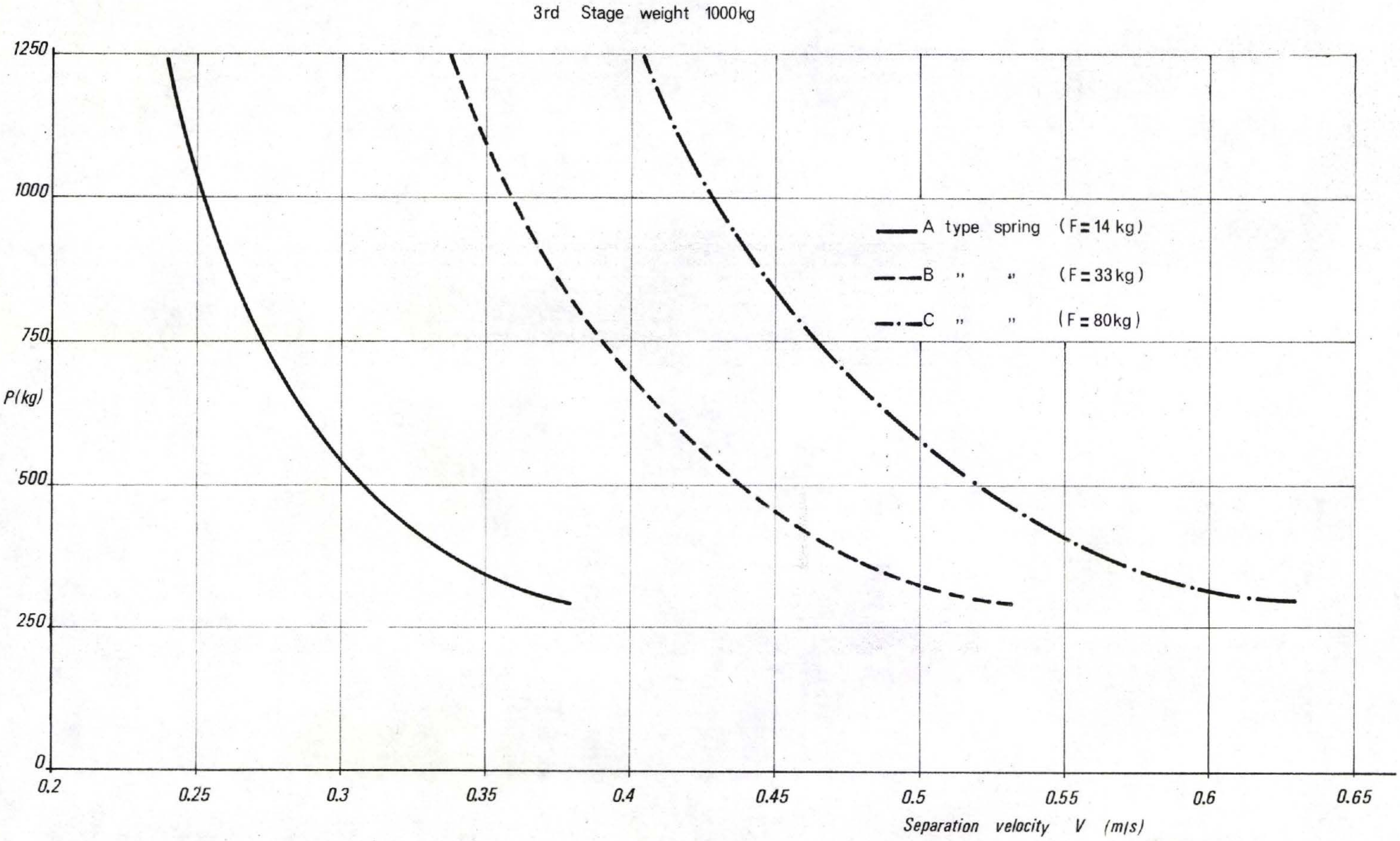
Titre: **EUROPA 1**
Pin of the 1100mm separation system

Page:
Figure: 4.2
AL.0

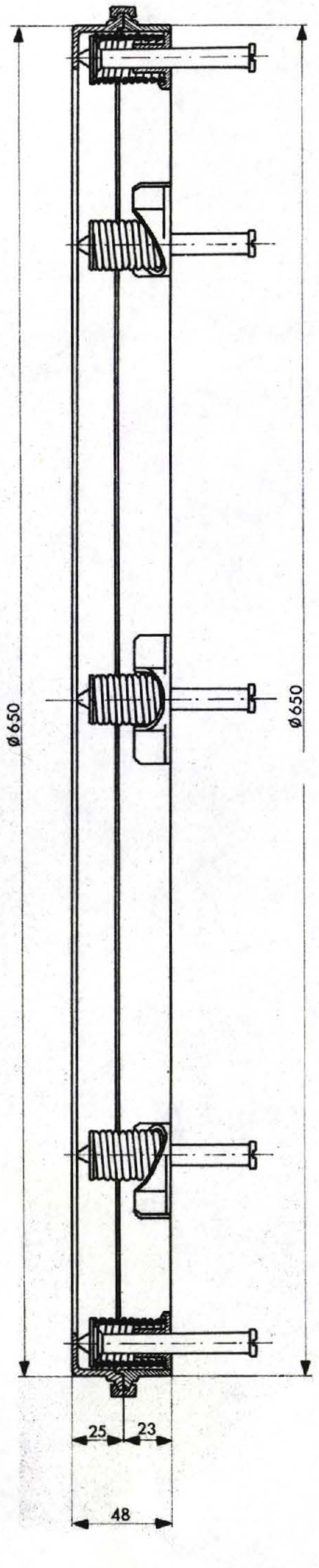
Dessiné par:
Vérifié par:

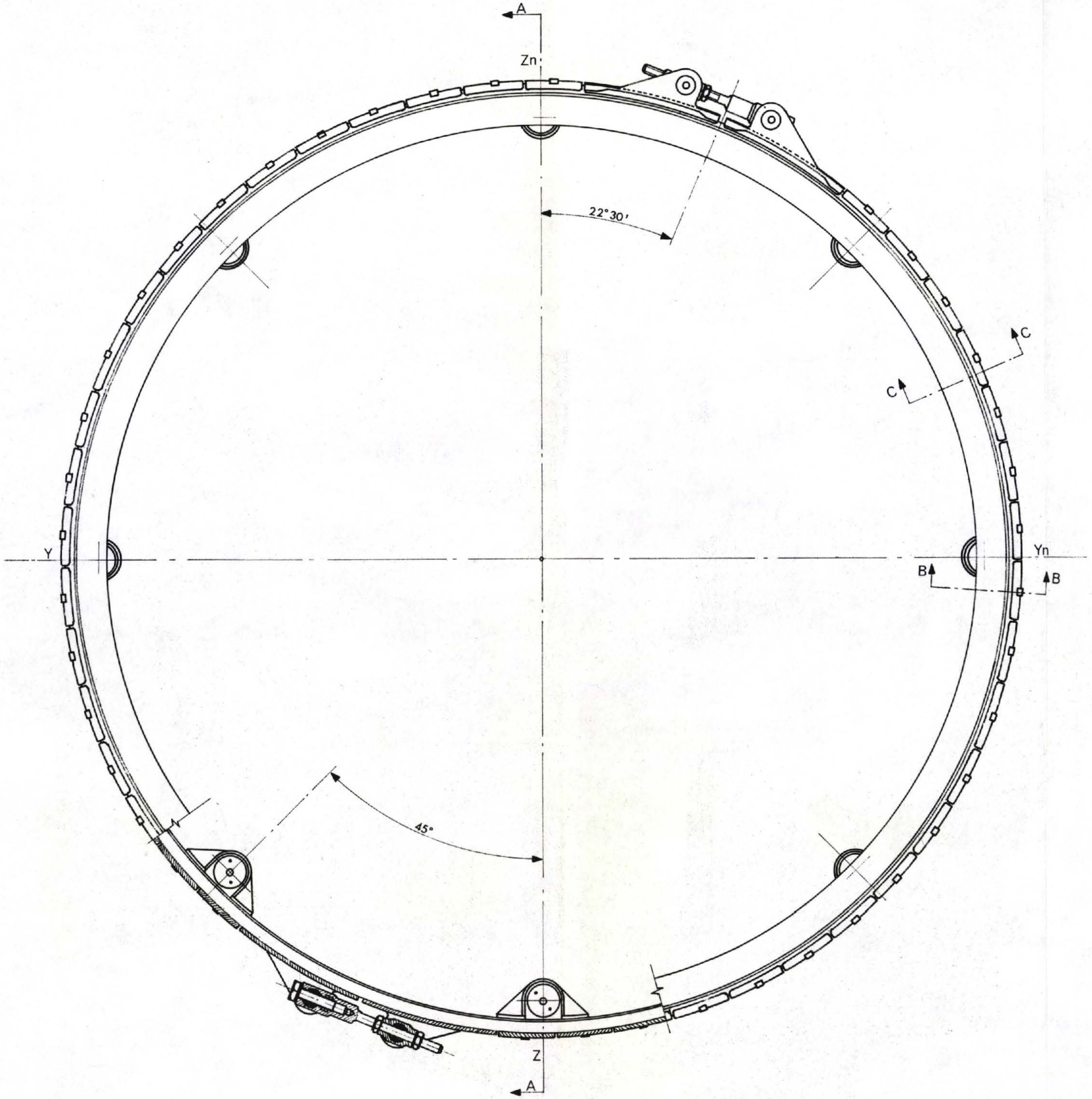
Titre: **EUROPA 1**
Sepation velocity versus satellite weight

Page
Figure 4.3
AL.0

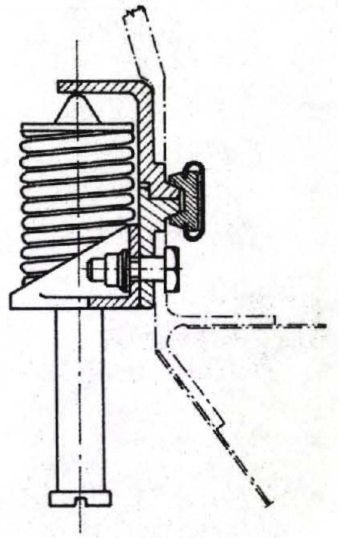


Section AA

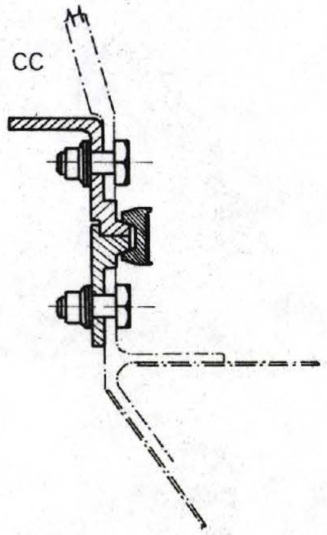




Section BB



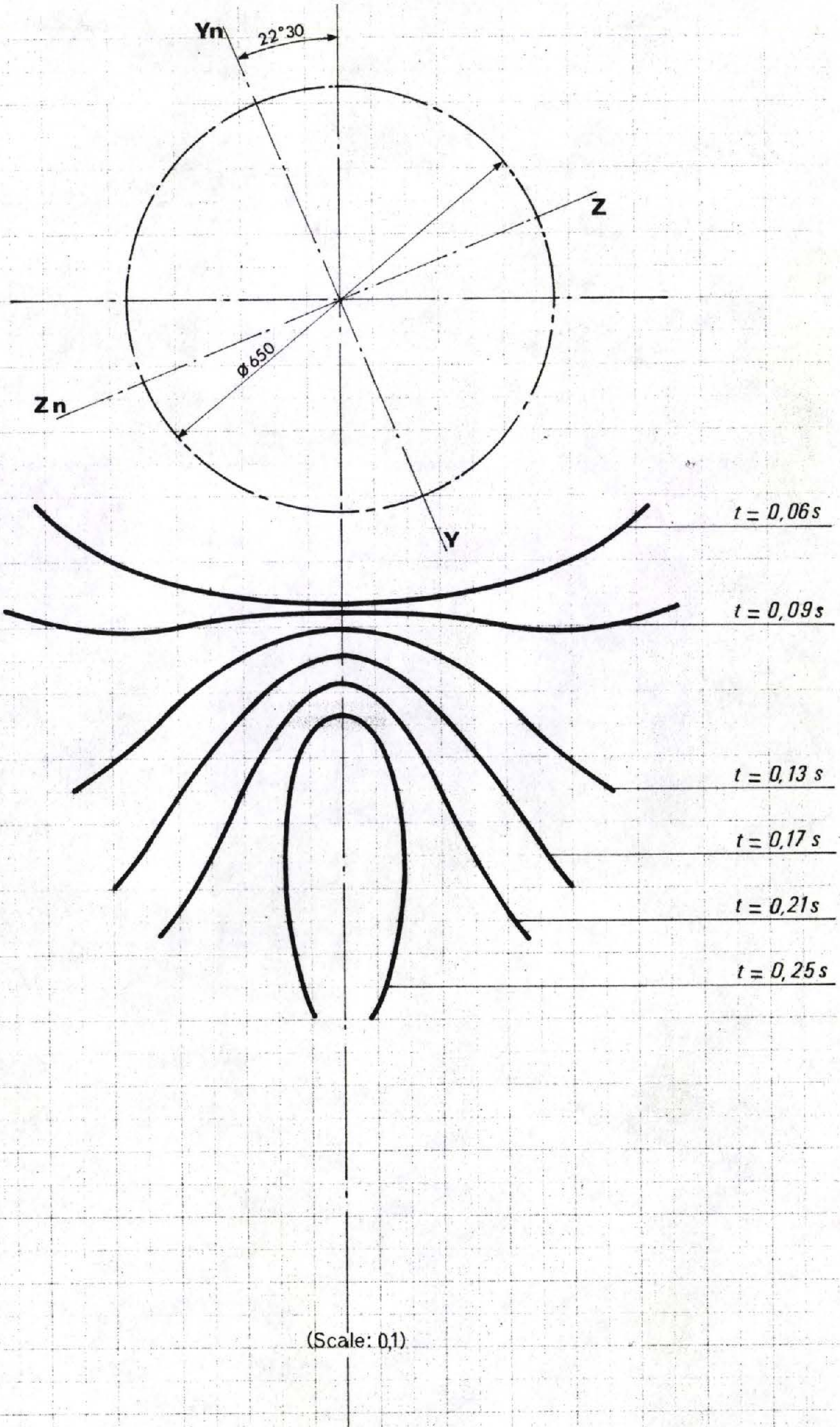
Section CC



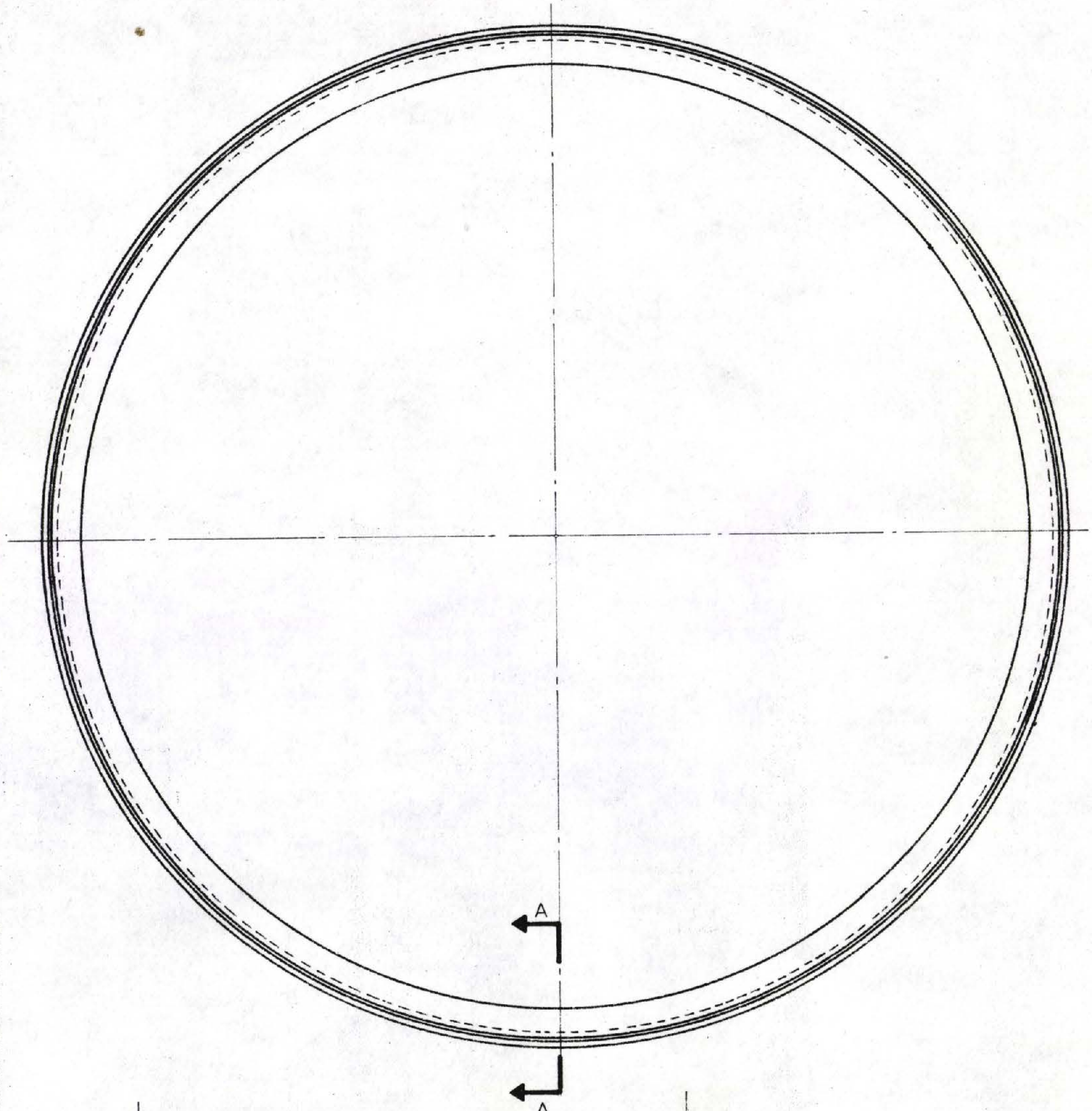
Dessiné par.
Vérifié par.

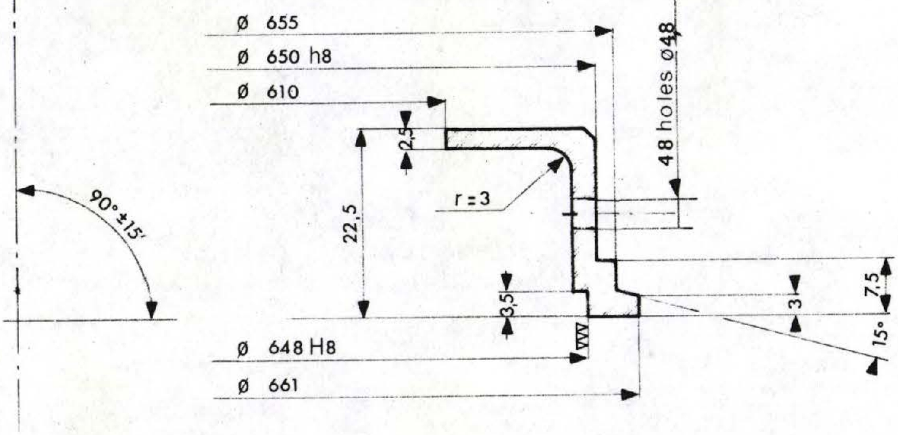
Titre
EUROPA I
650 mm separation system

Page
Figure 4.4
AL.0



Dessiné par	*Titre.*	**EUROPA 1**	*Page*
Vérifié par		Dynamics of 650mm dia. separation	*Figure* 4.5 AL.0





Section A

Material 7075 T 651

Dessiné par: Nandyd

Vérifié par:

Titre: **EUROPA 1**

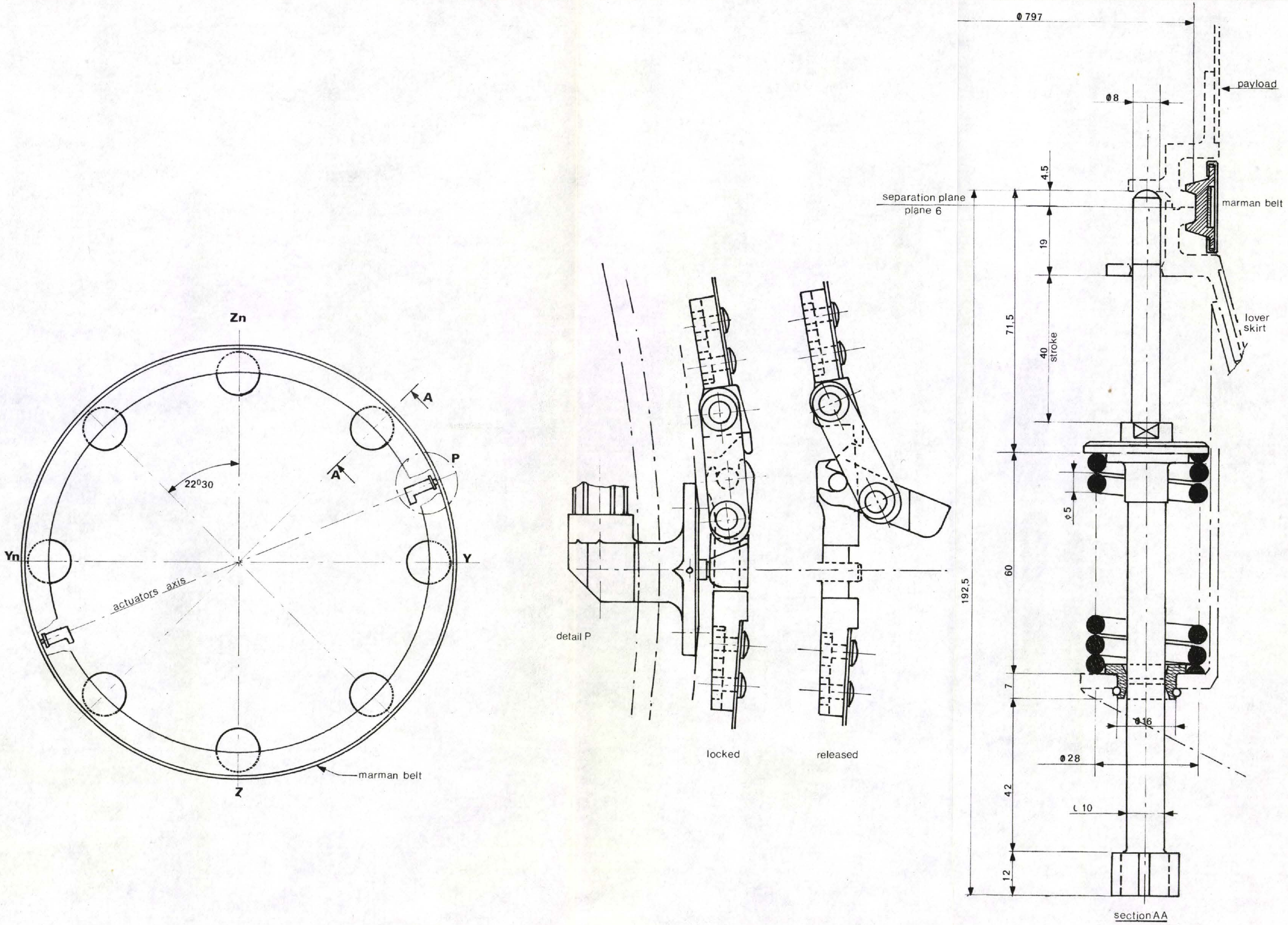
Upper ring of the

650 separation system

Page:

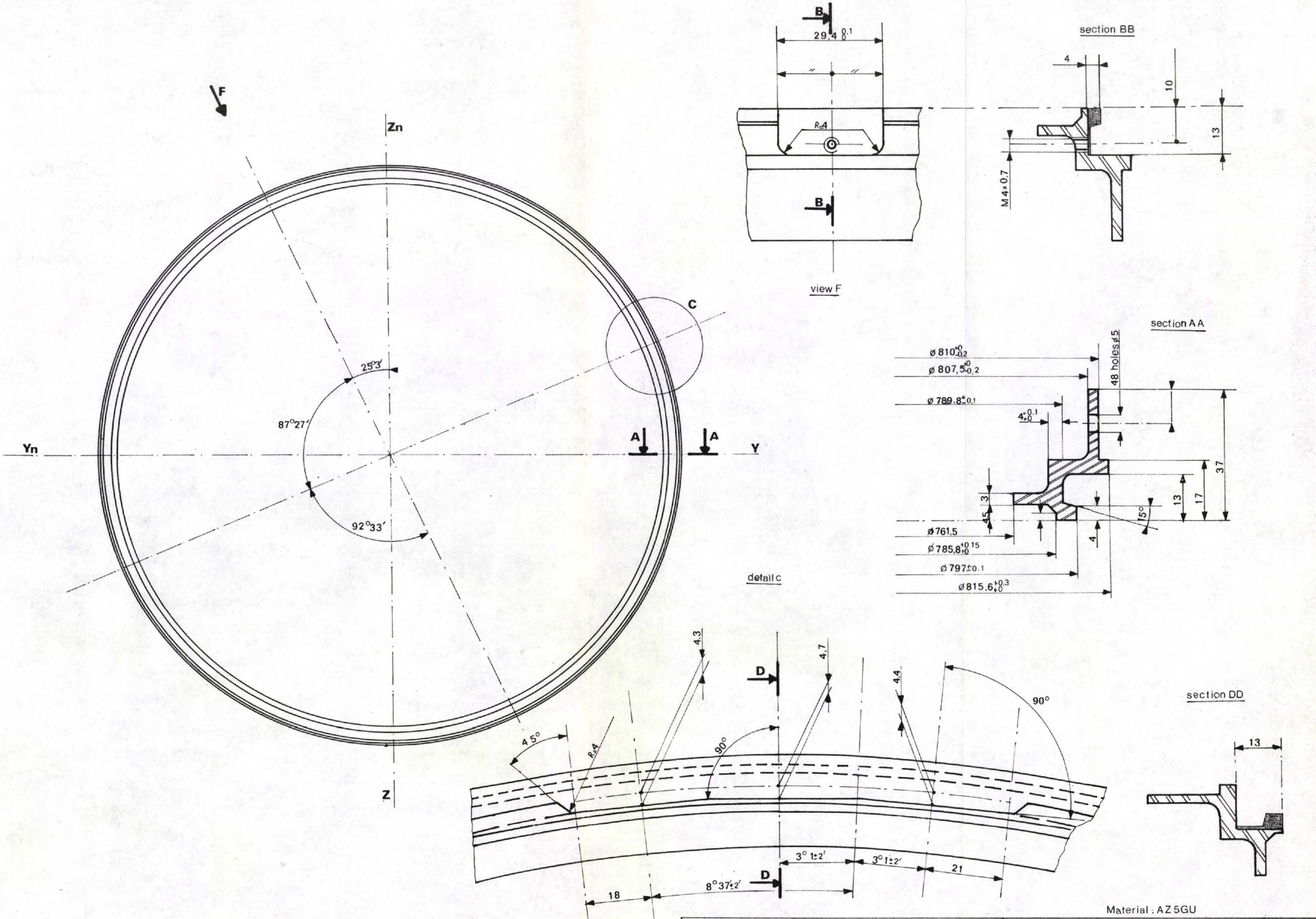
Figure 4.6

AL.0



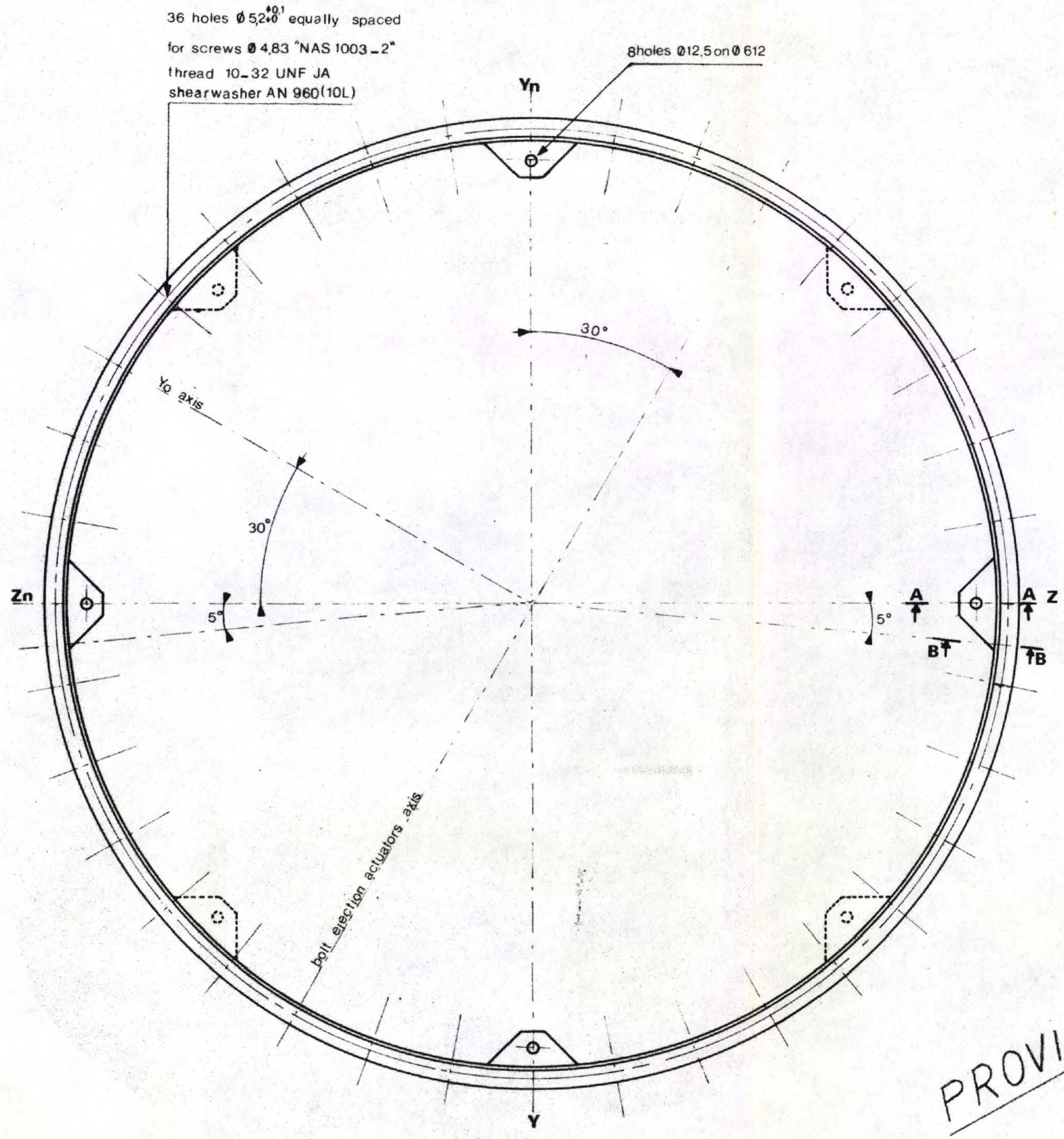
N.B: this skirt is also used in EUROPA 2 as a support for the perigee stage

Dessine par Nanard *Vérifié par*	*Titre* **EUROPA 1** 810 mm separation system	*Page* *Figure* 4.7 AL.0



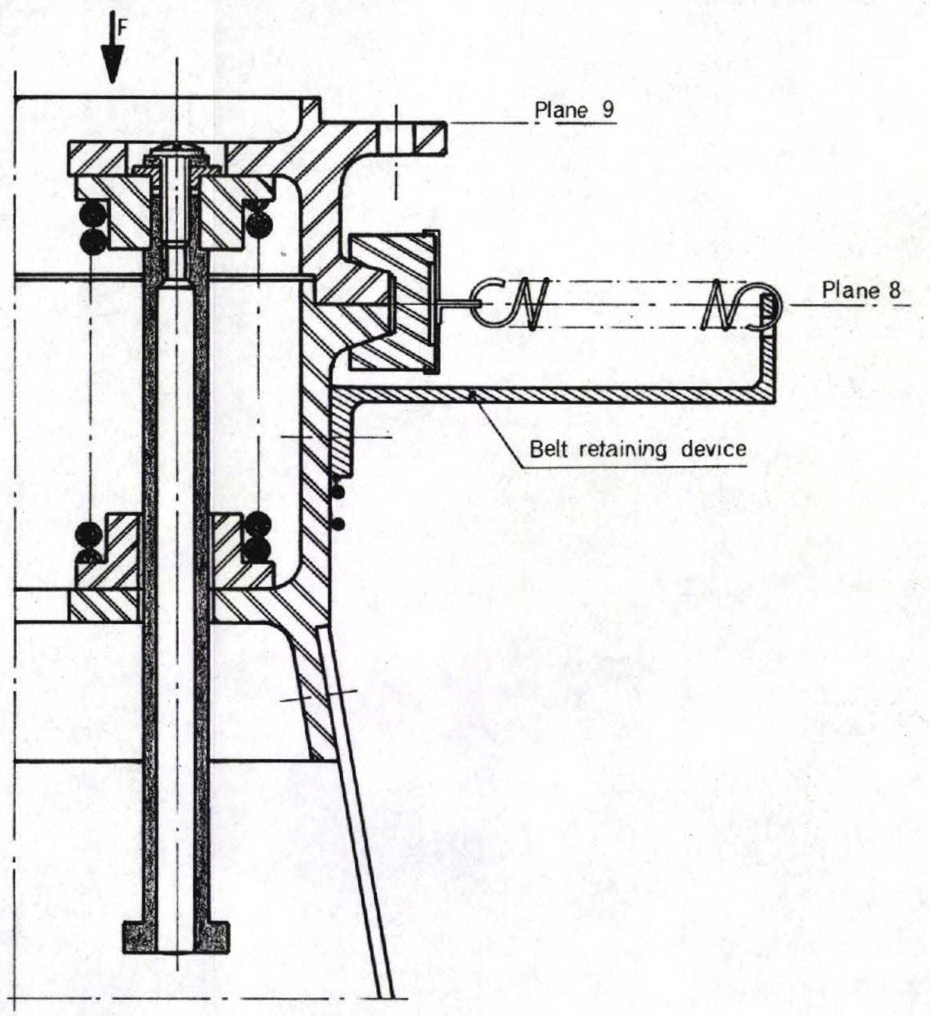
Material : AZ 5GU

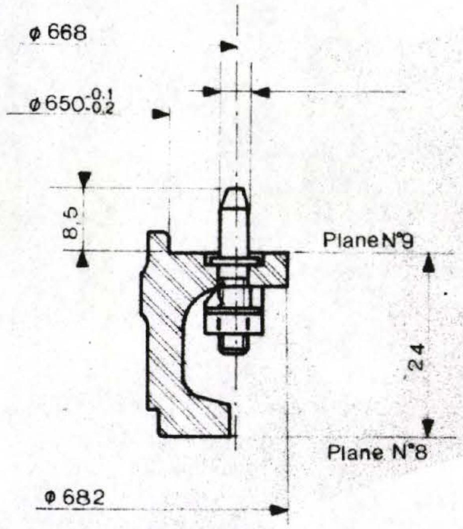
Dessiné par: Haug *Vérifié par:*	*Titre* **EUROPA 1** Upper ring of 810mm separation system	*Page:* *Figure:* 4.8 AL.O


36 holes Ø 5,2$^{+0,1}_{+0}$ equally spaced
for screws Ø 4,83 "NAS 1003 – 2"
thread 10 – 32 UNF JA
shearwasher AN 960(10L)
8holes Ø12,5 on Ø 612
Yn
30°
Yo axis
30°
Zn
5°
5°
A
A
Z
B
B
bolt ejection actuators axis
Y

View F

Section B





section B

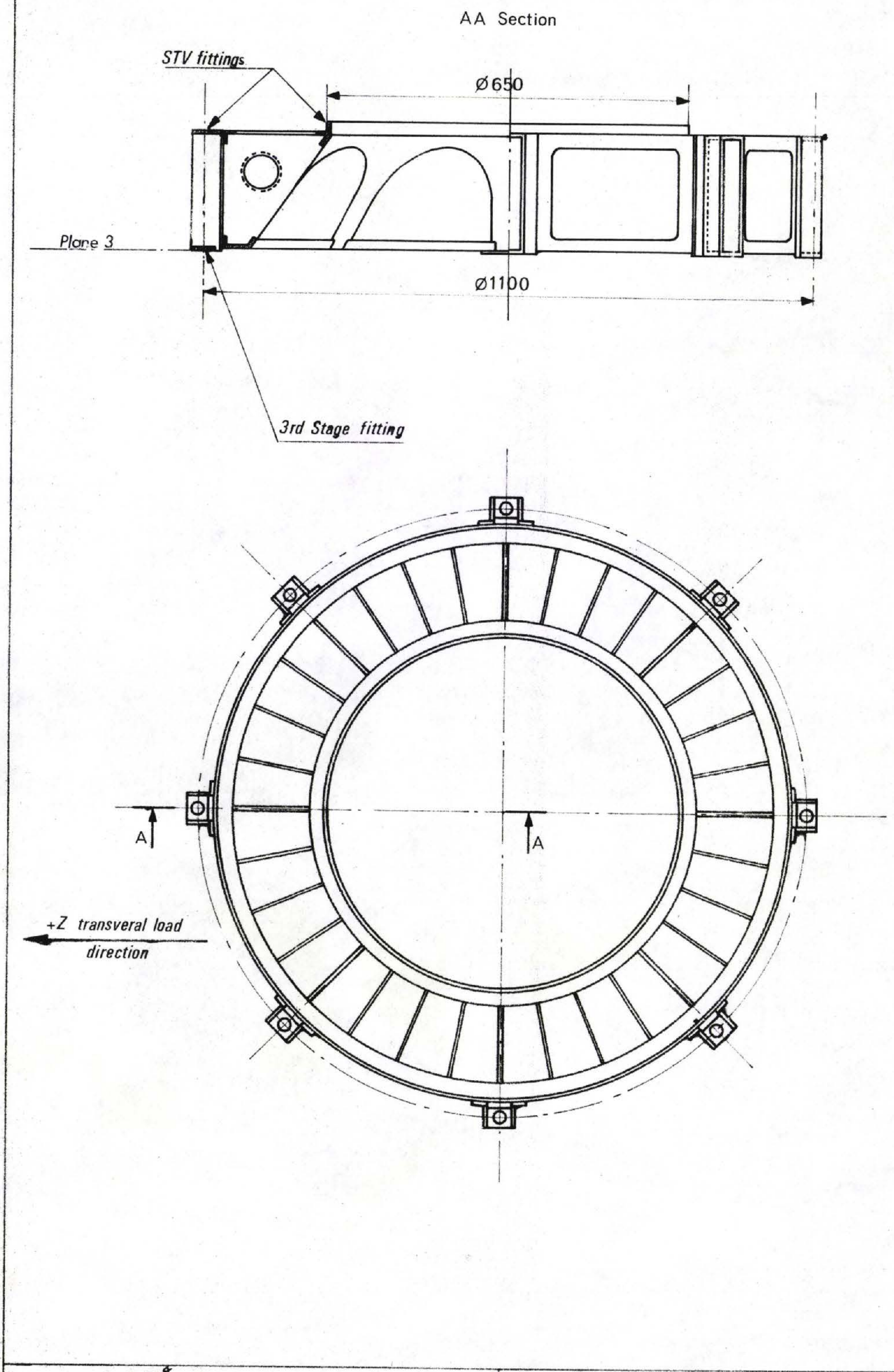
PROVISIONAL

NOTA: surface condition on PLANE N°9 $\nabla^{0.8}$

Dessine par
Verifie par

Titre **EUROPA II**
650 mm separation system

Page
Figure 4.9
AL.0



Dessiné par:
Vérifié par:

Titre:

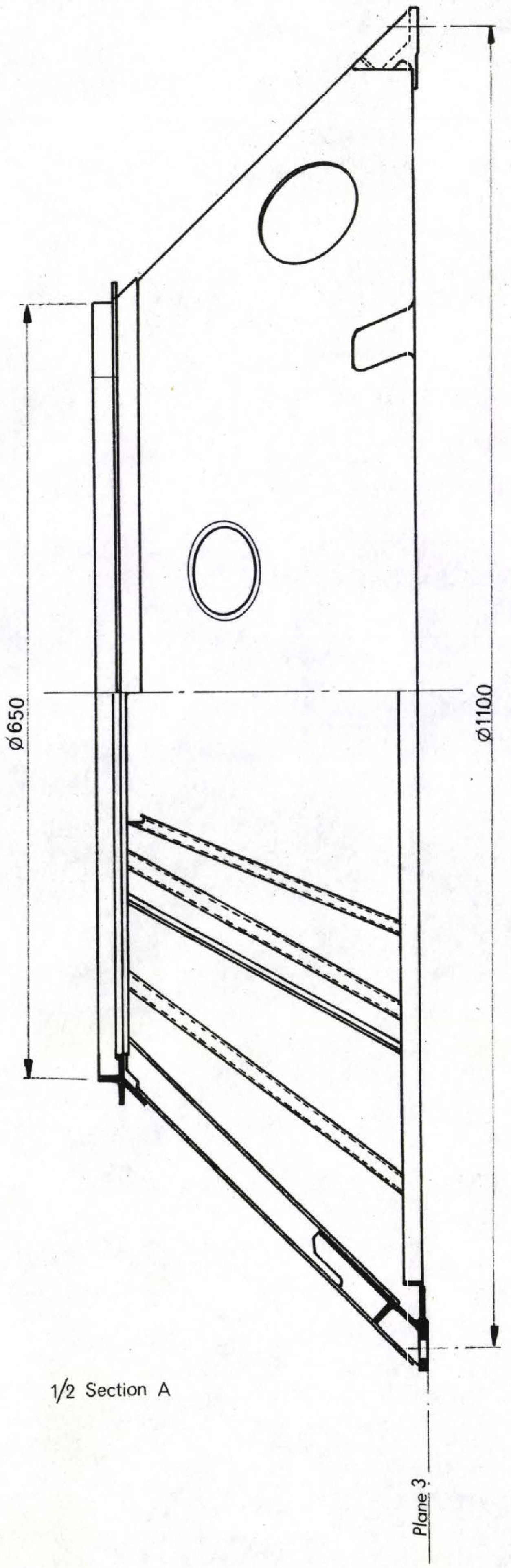
EUROPA 1

Flat Adaptor

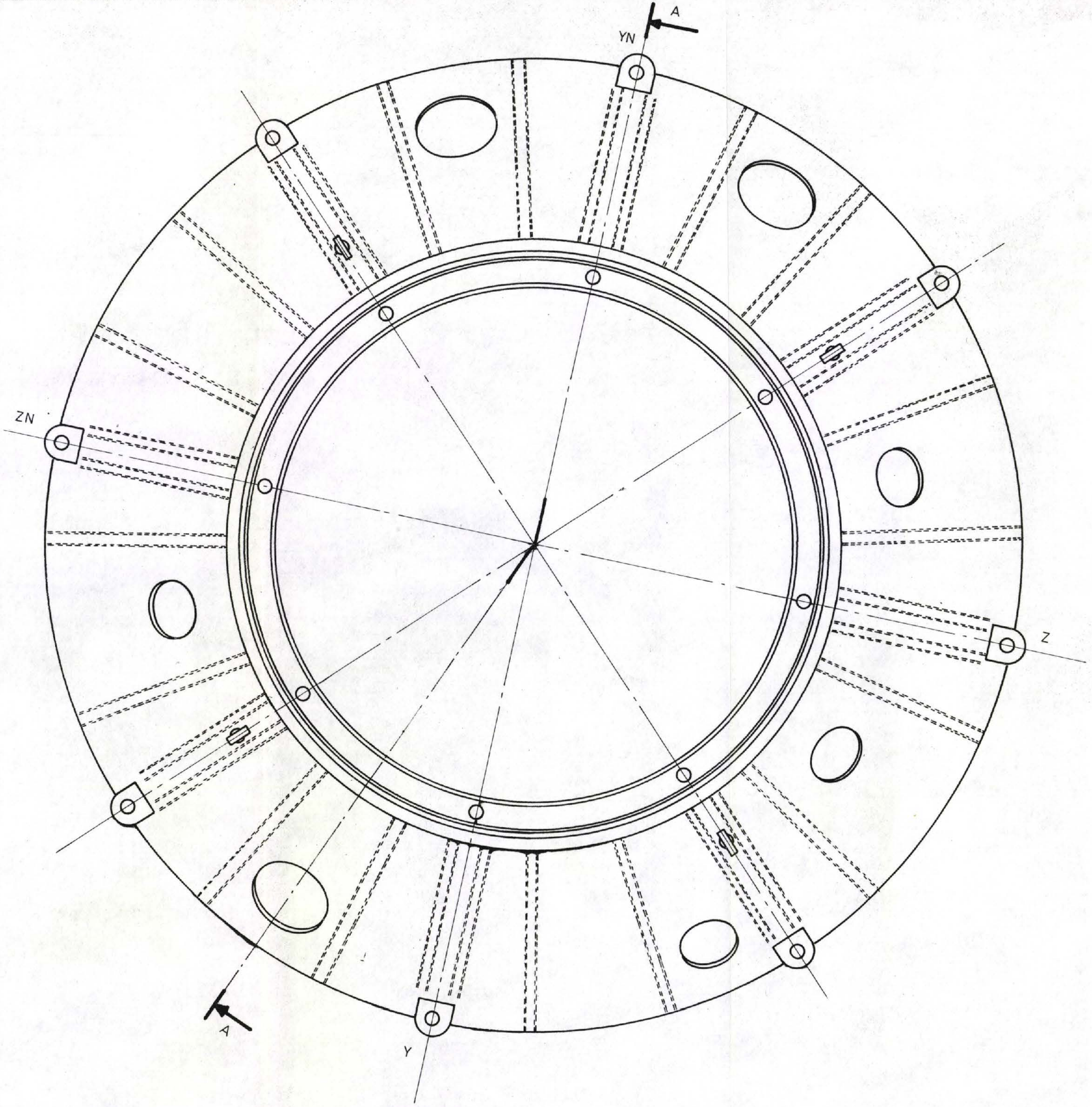
Page:

Figure: 4.10

AL.0



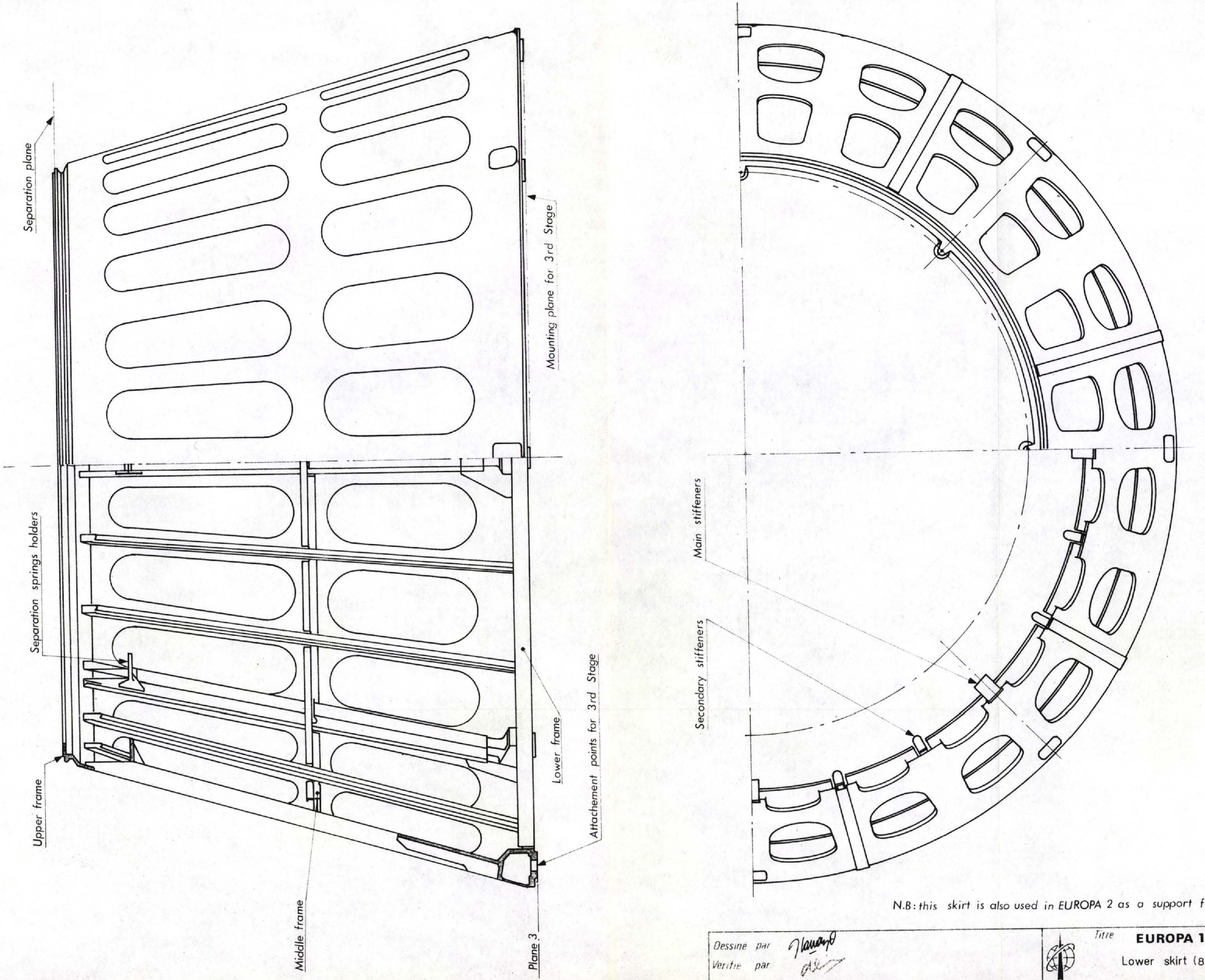
1/2 Section A



Dessiné par:
Vérifié par:

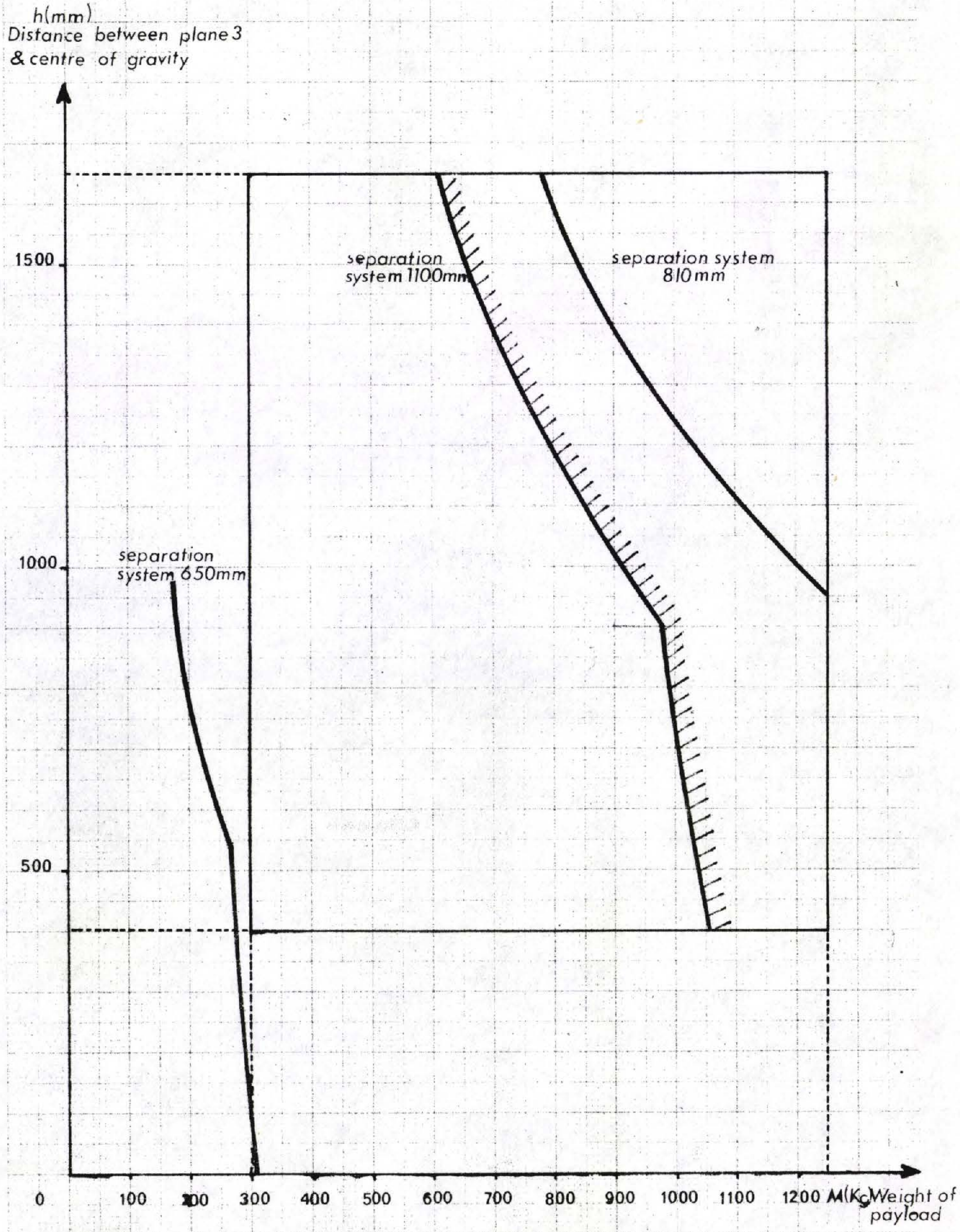
Titre: **EUROPA 1**
Tapered adapter

Page
Figure: 4.11
AL.0



N.B: this skirt is also used in EUROPA 2 as a support for the perigee stage

Dessine par Verifie par	Titre **EUROPA 1** Lower skirt (810 mm separation)	Page Figure 4.12 AL.0

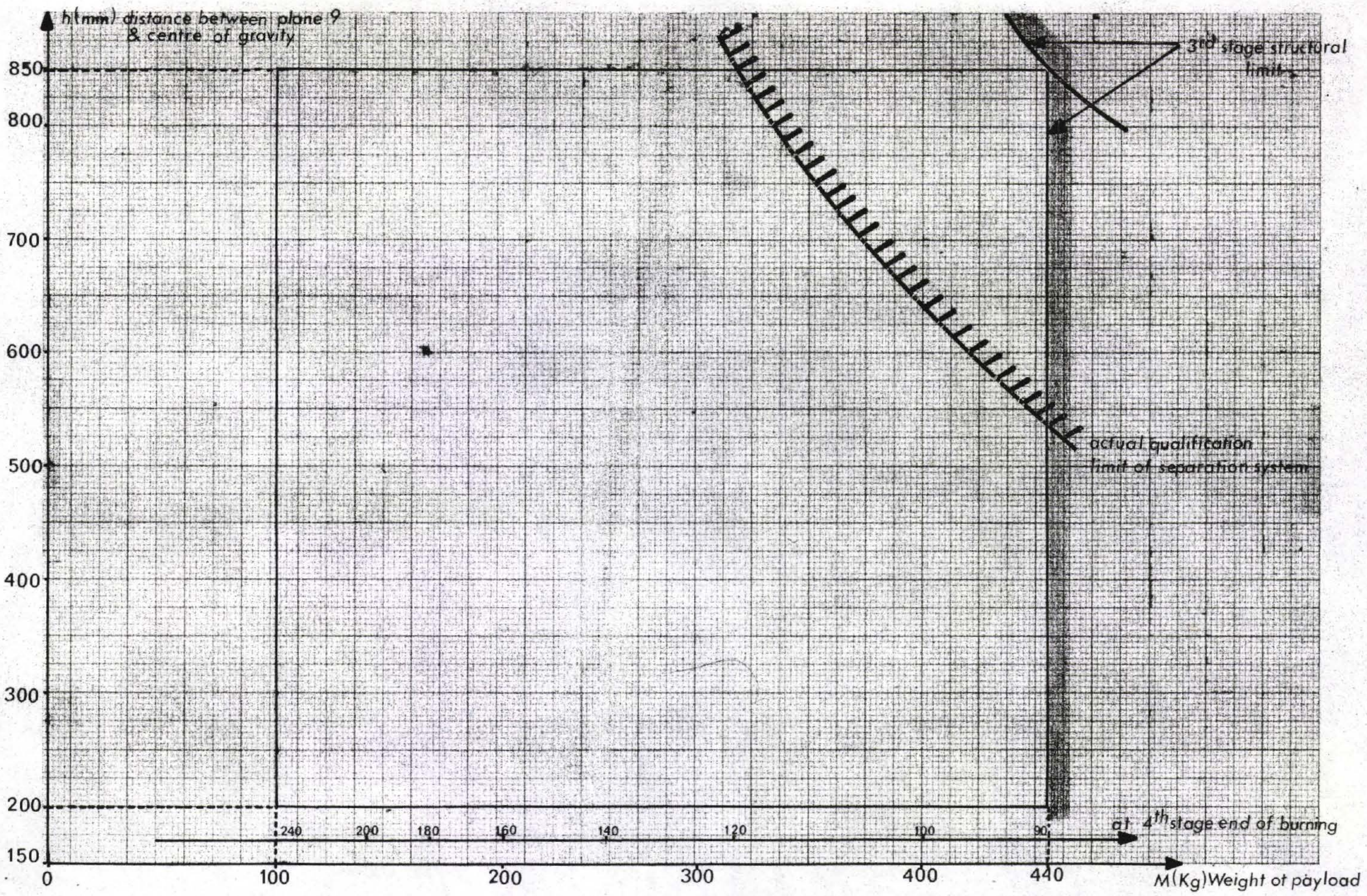


Dessiné par:
Vérifié par:

Titre **EUROPA 1**

Structural limit

Page
Figure 4.13
AL.C

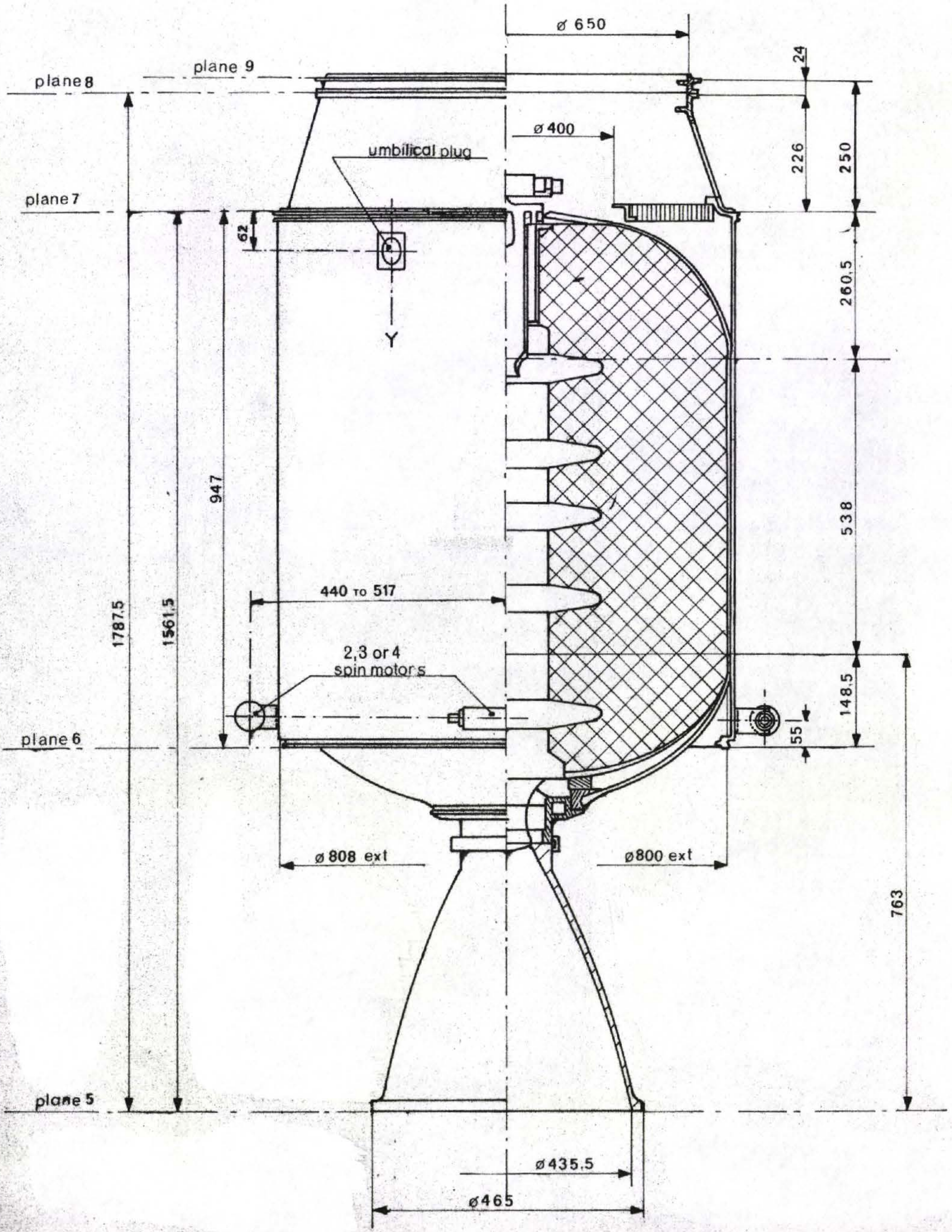


Dessiné par:
Vérifié par:

Titre: **EUROPA 2**

Structural limit

Page:
Figure 4.14
AL.O

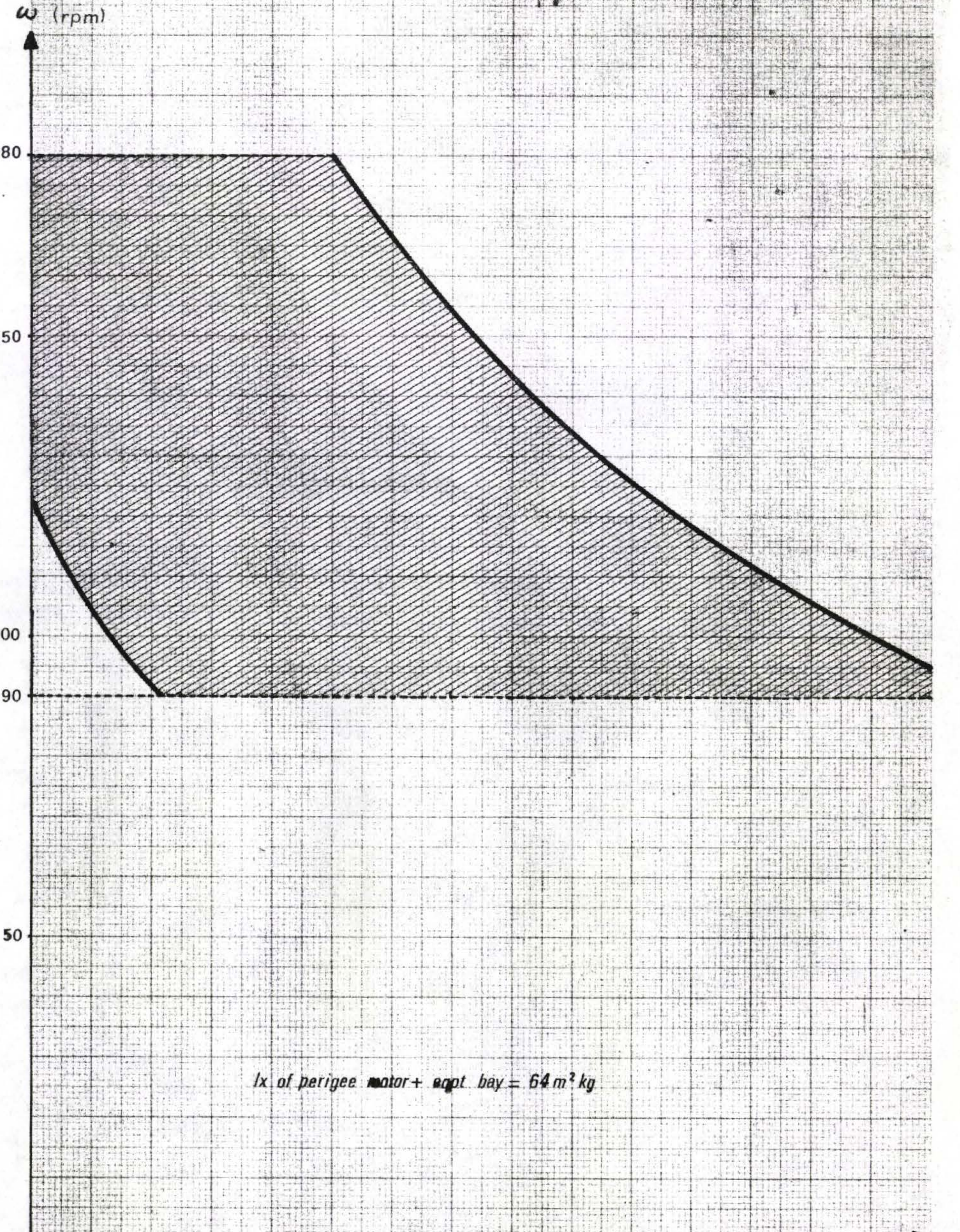


Dessiné par:
Vérifié par:

Titre: **EUROPA 2**

Perigee stage

Page:
Figure 4.15
AL.0



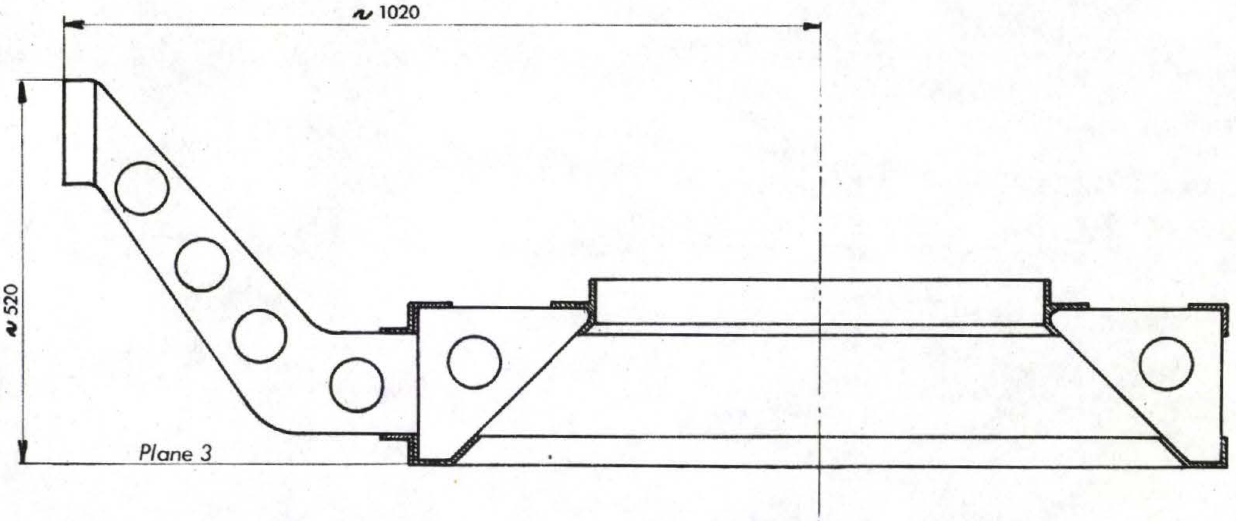
Dessiné par:
Vérifié par:

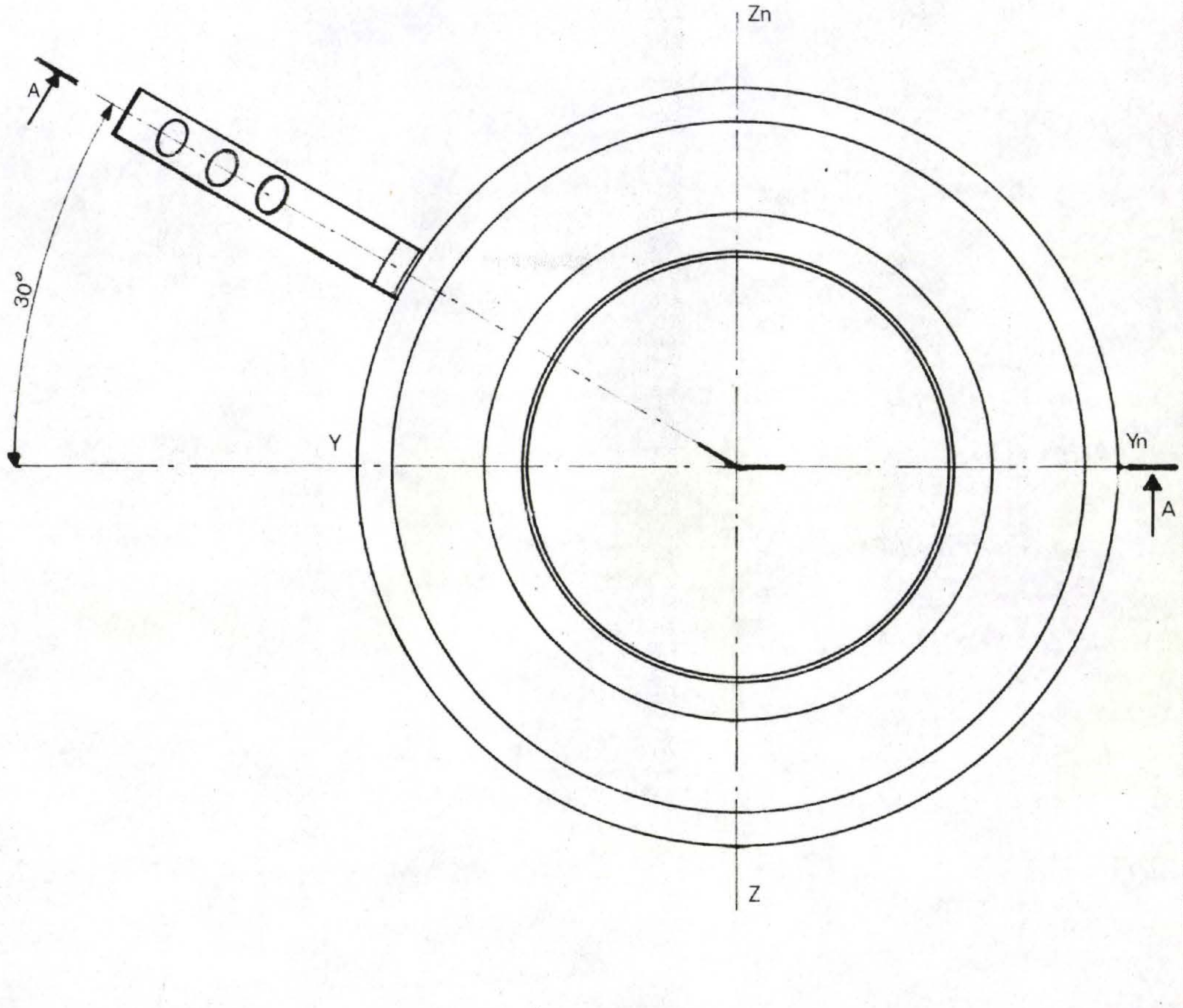
Titre: **EUROPA 2**

Roll moment of inertia versus spin rate

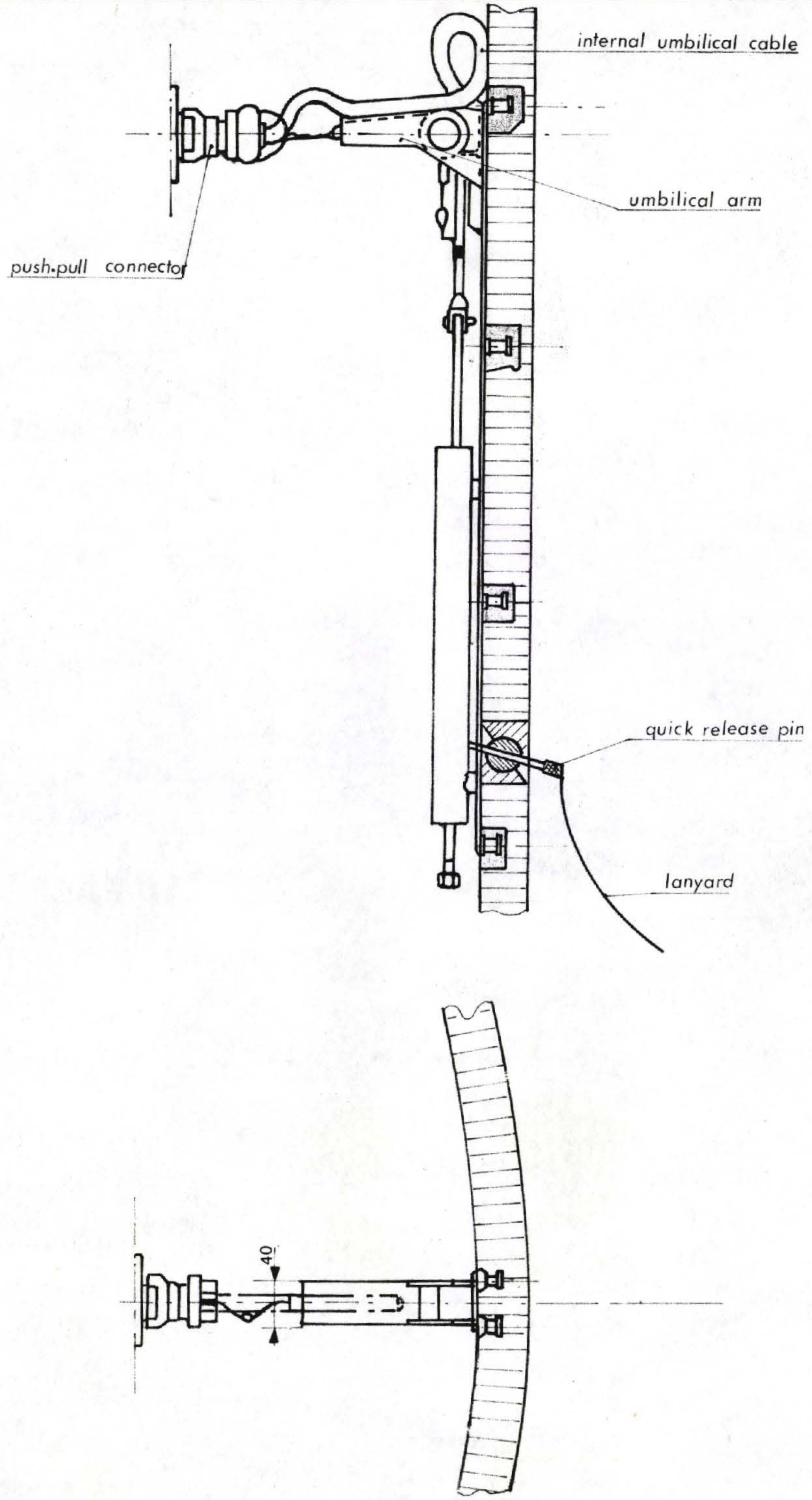
Page:
Figure: 4.16
AL.0

Section A





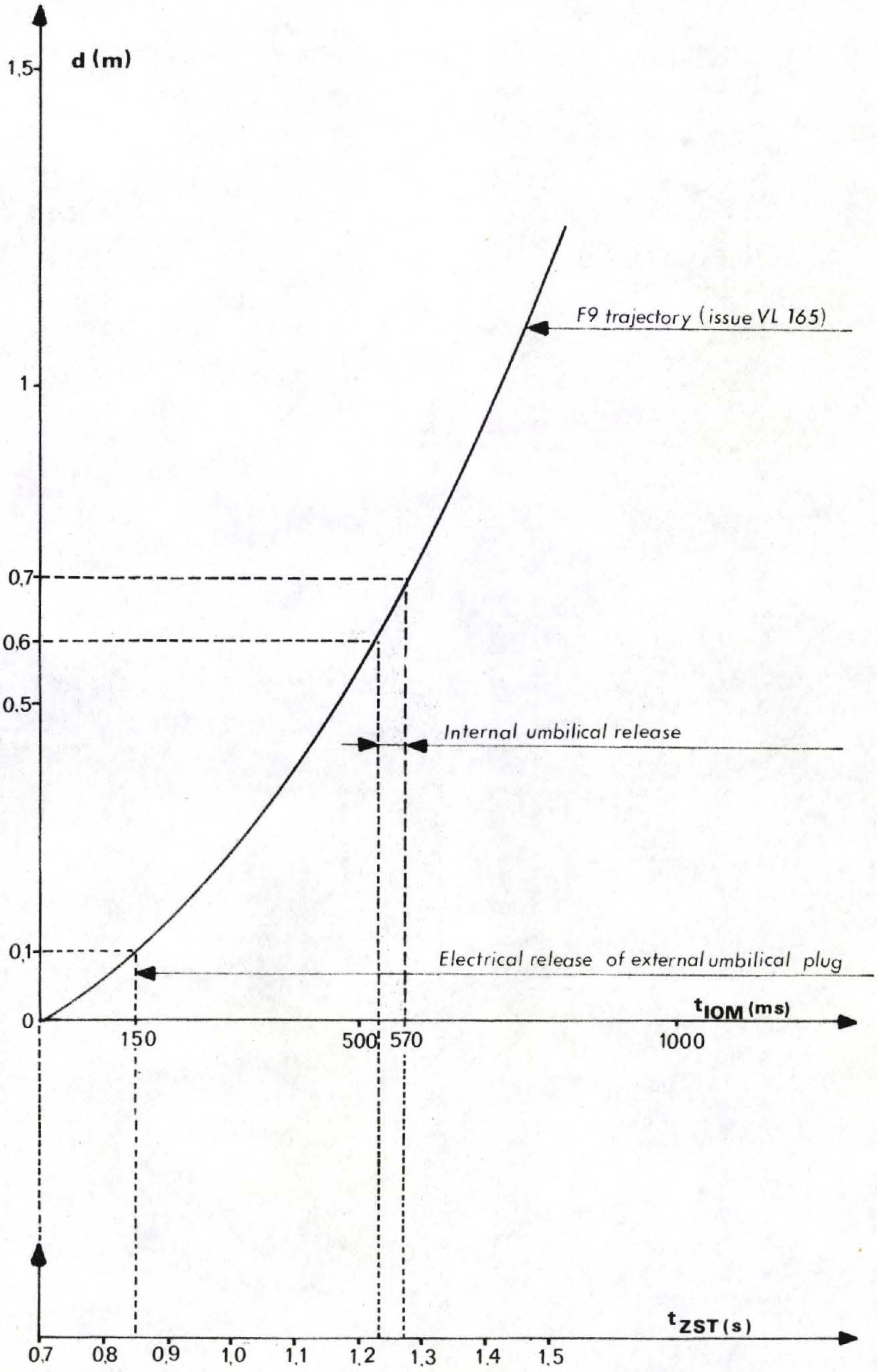
Dessiné par: *Vérifié par:*	*Titre:* **EUROPA I** Location of umbilical plug	*Page:* *Figure.* 4.17 AL.0



Dessiné par:
Vérifié par:

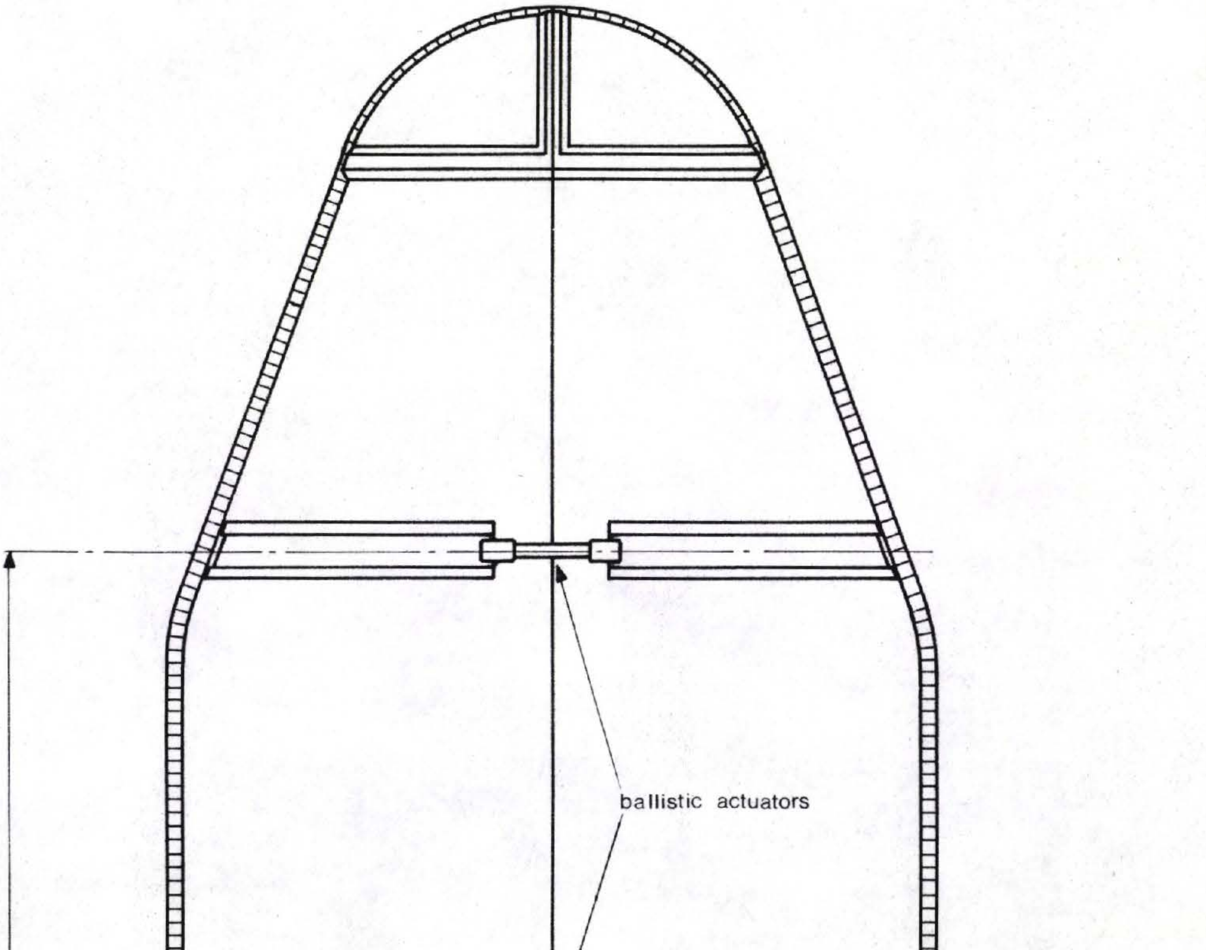
Titre: **EUROPA 1 & 2**
Quick disconnect umbilical

Page:
Figure: 4.18
AL.O



$t_{ZST} = t_{IOM} + 0.7\,s$

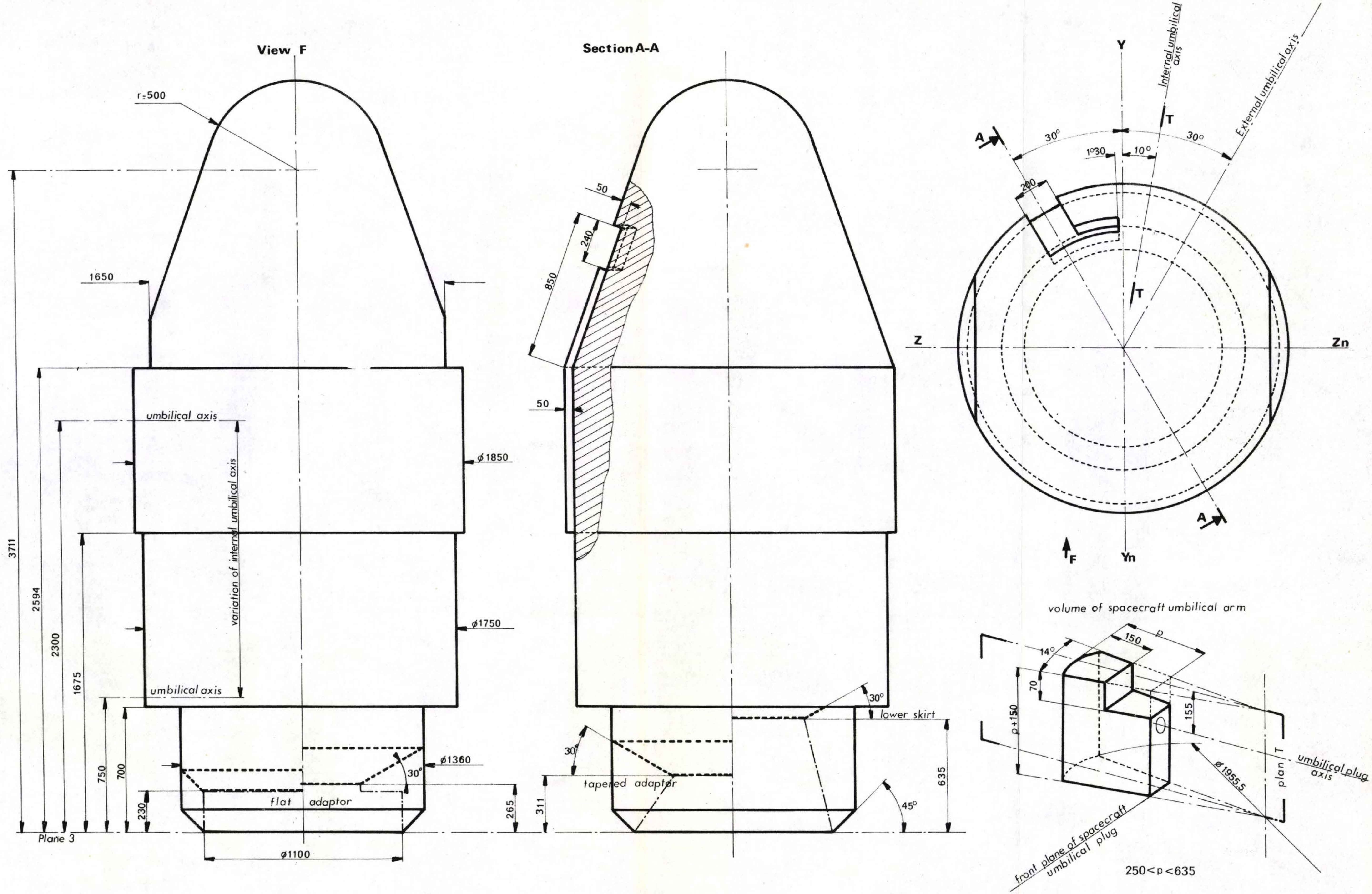
Dessiné par: *Vérifié par:*	*Titre:* **EUROPA 1 & 2** Spacecraft umbilicals – Nominal release sequence	*Page:* *Figure:* 4.19 AL.0



Dessiné par:
Vérifié par:

Titre: **EUROPA 1&2**
Nose fairings separation system

Page :
Figure:4_20
AL.0

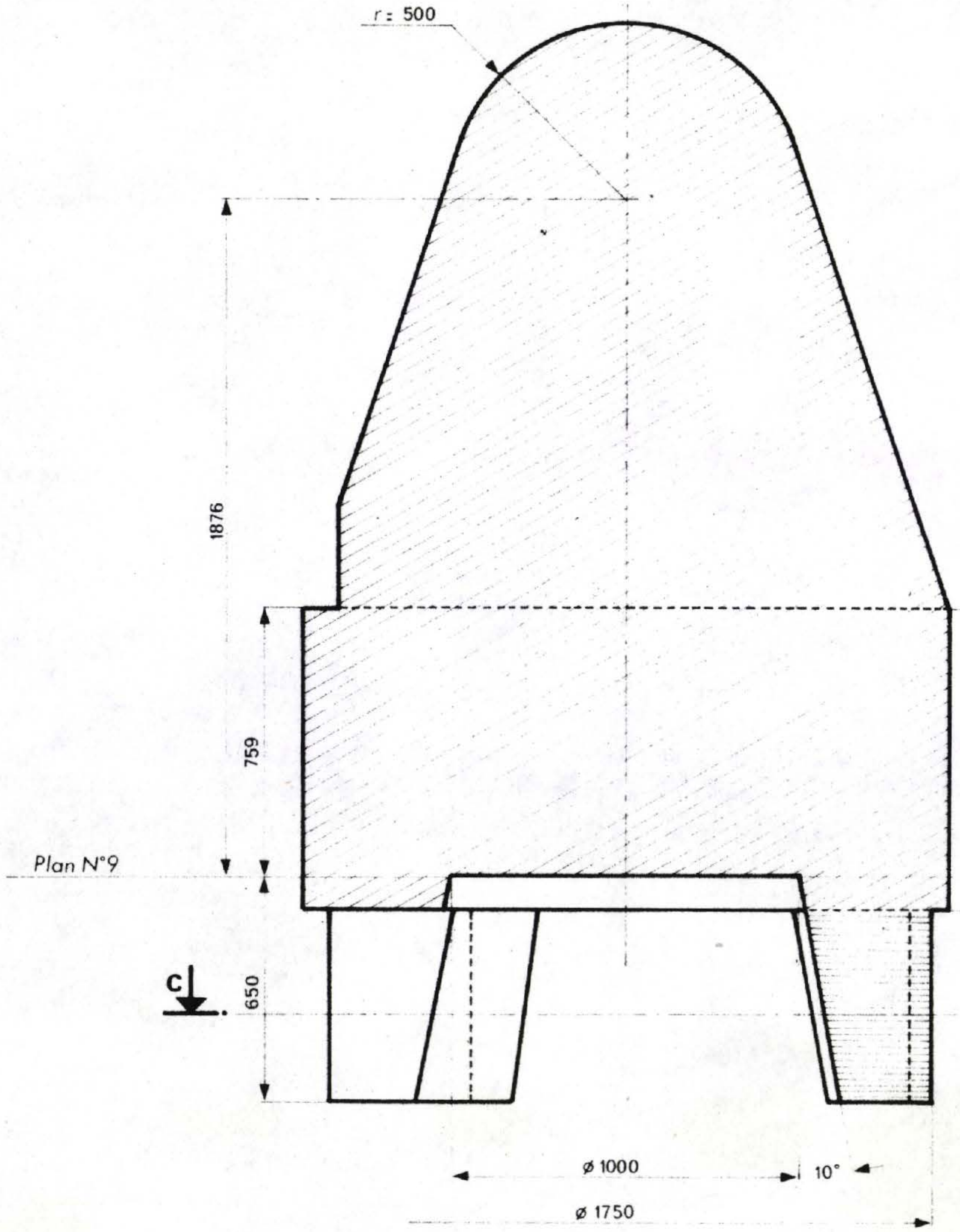


Dessiné par: Hamayo
Vérifié par:

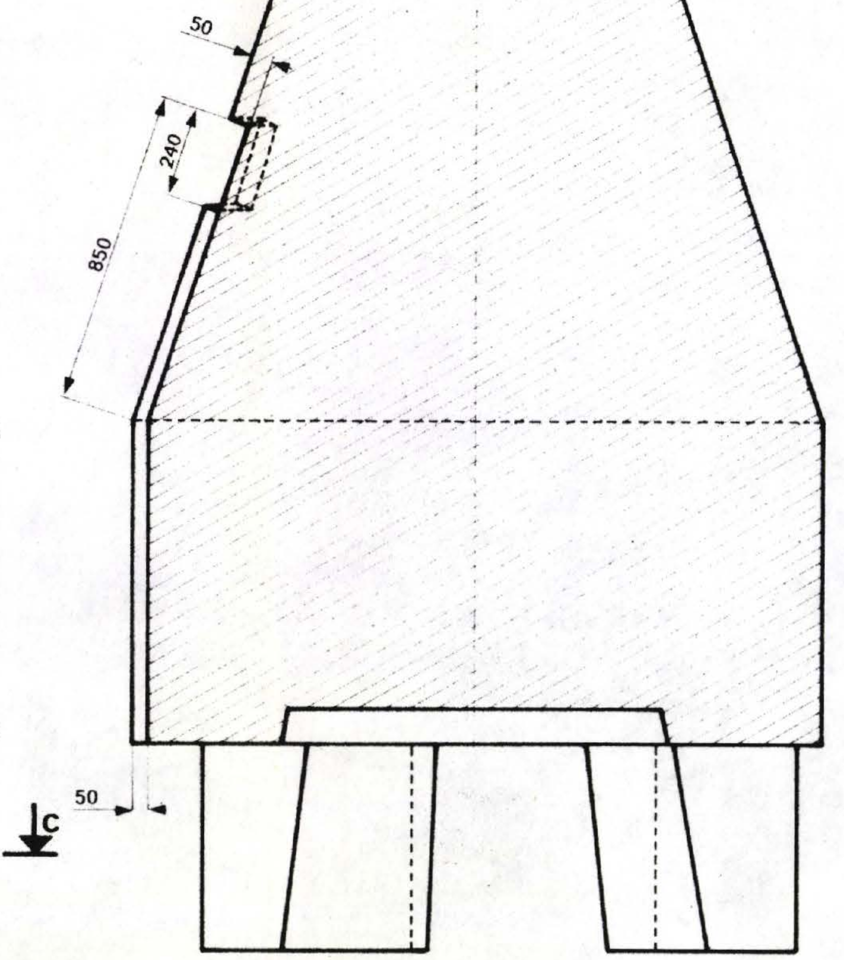
Titre: **EUROPA 1**
Maximum available volume for payloads

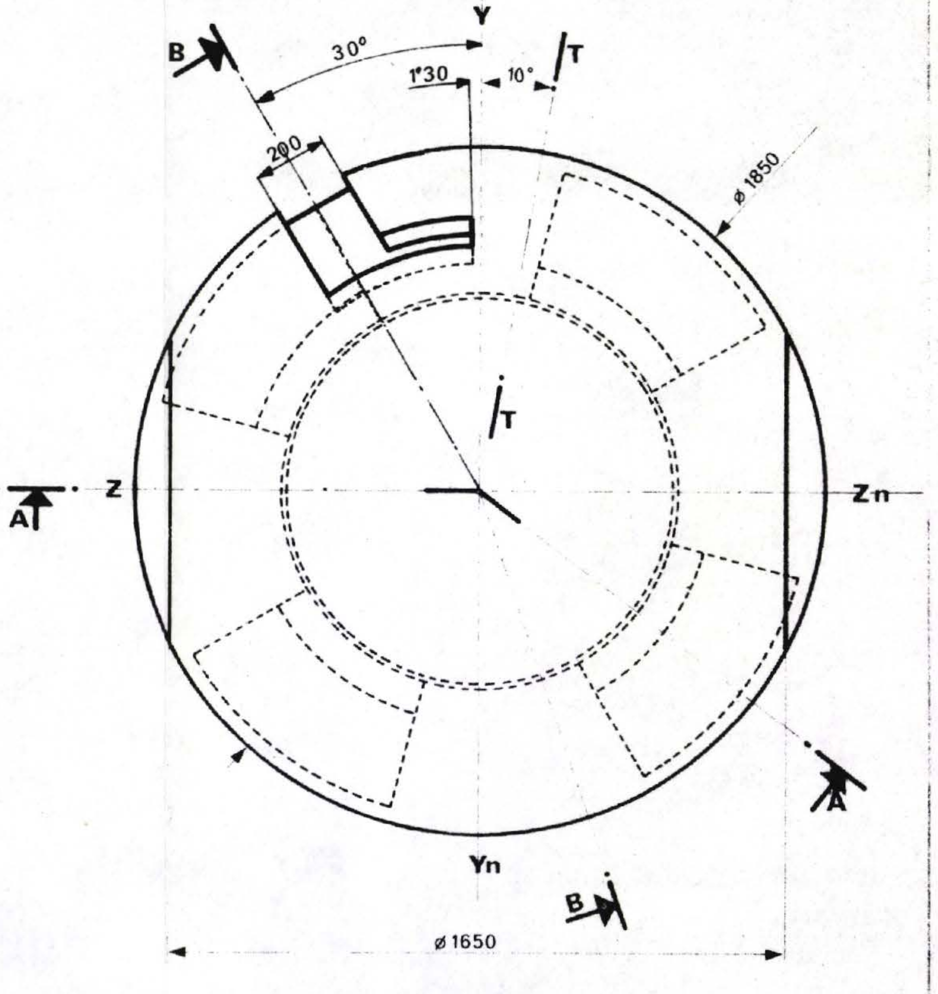
Page:
Figure 4-21
AL.0

Section A

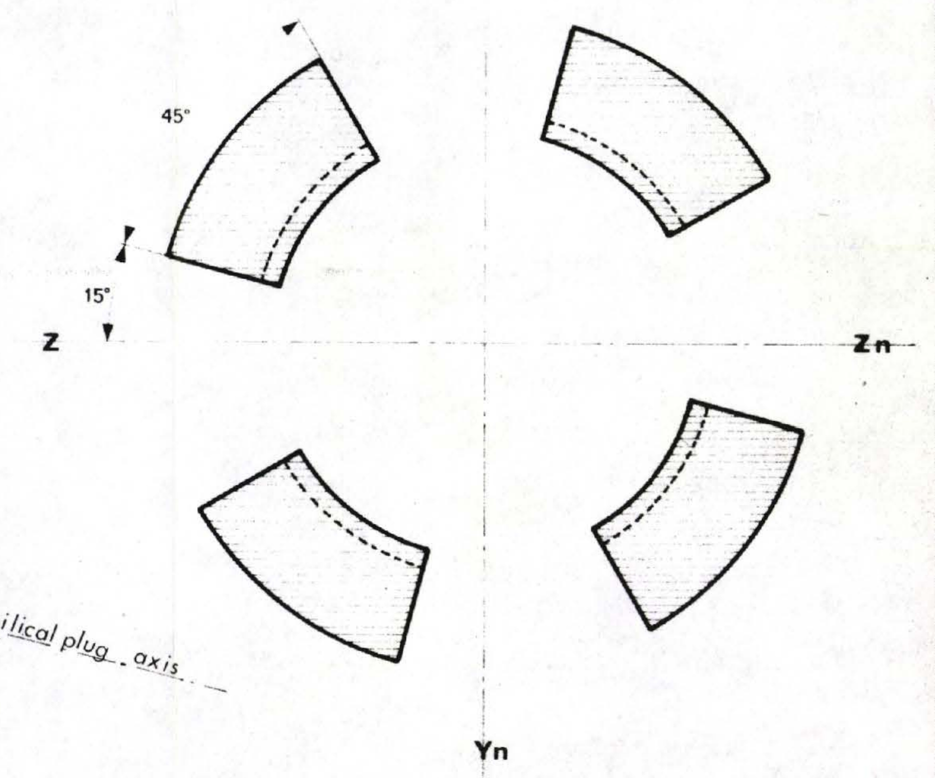


Section B

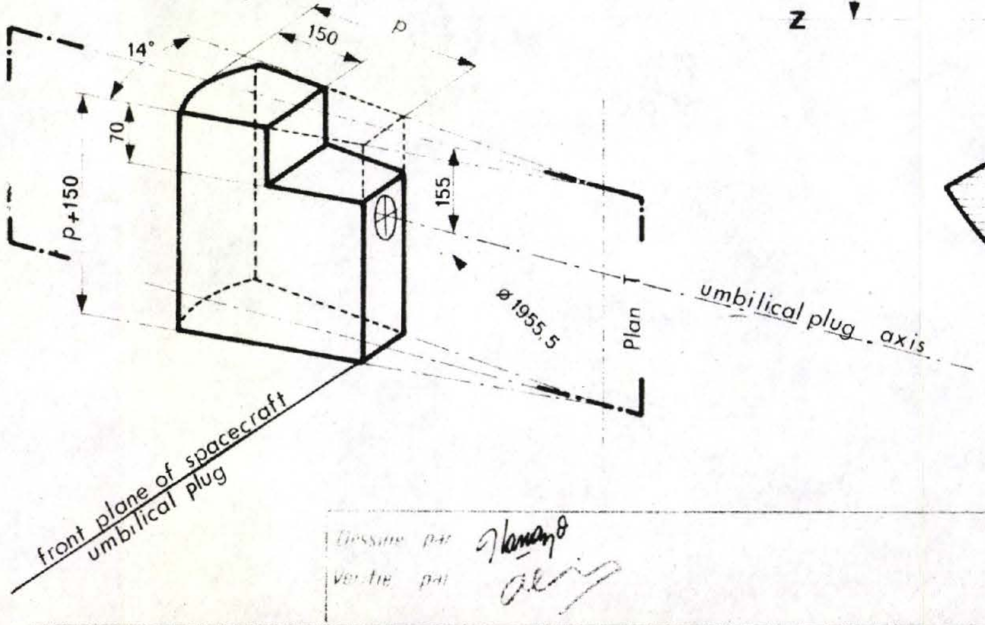




Section C



volume of spacecraft umbilical arm



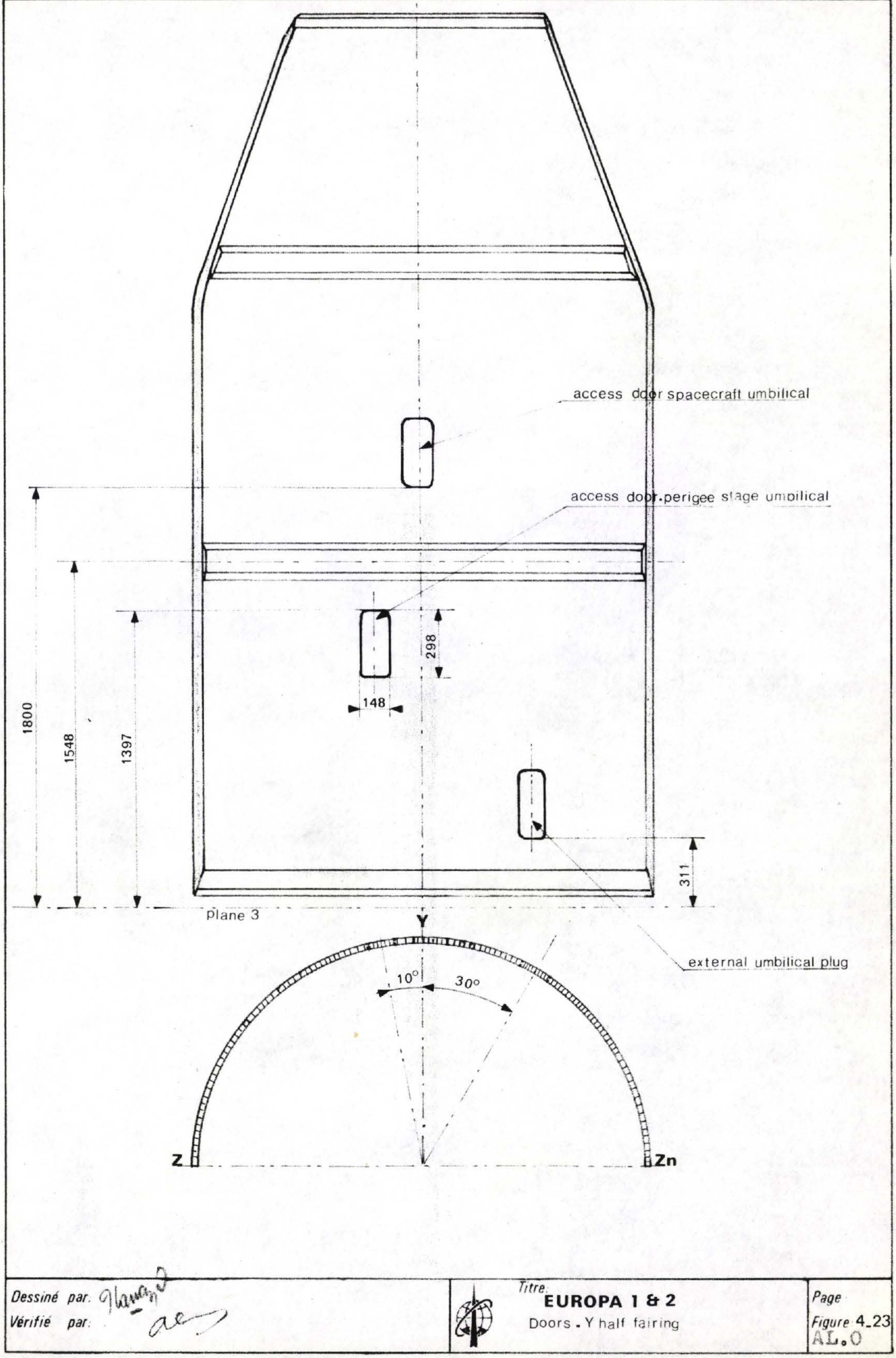
NOTES

1. Volumes ▤ will be available for antennae after study&agreement by ELDO
2. The spacecraft umbilical arm volume can be moved in plane T. Dimension p depends on the umbilical plug position. This volume must be subtracted from the volume available for the spacecraft and antennae
3. Plane No 8 (separation plane) is located 24 mm below plane No9
4. The range of variation for p is
   $250 < p < 380$
5. Positions of umbilical plug axis referred to plane No9 must be comprised between
   - 75 mm and
   + 465 mm

Dessiné par
Vérifié par
Date

EUROPA 2
Maximum available volume for payloads

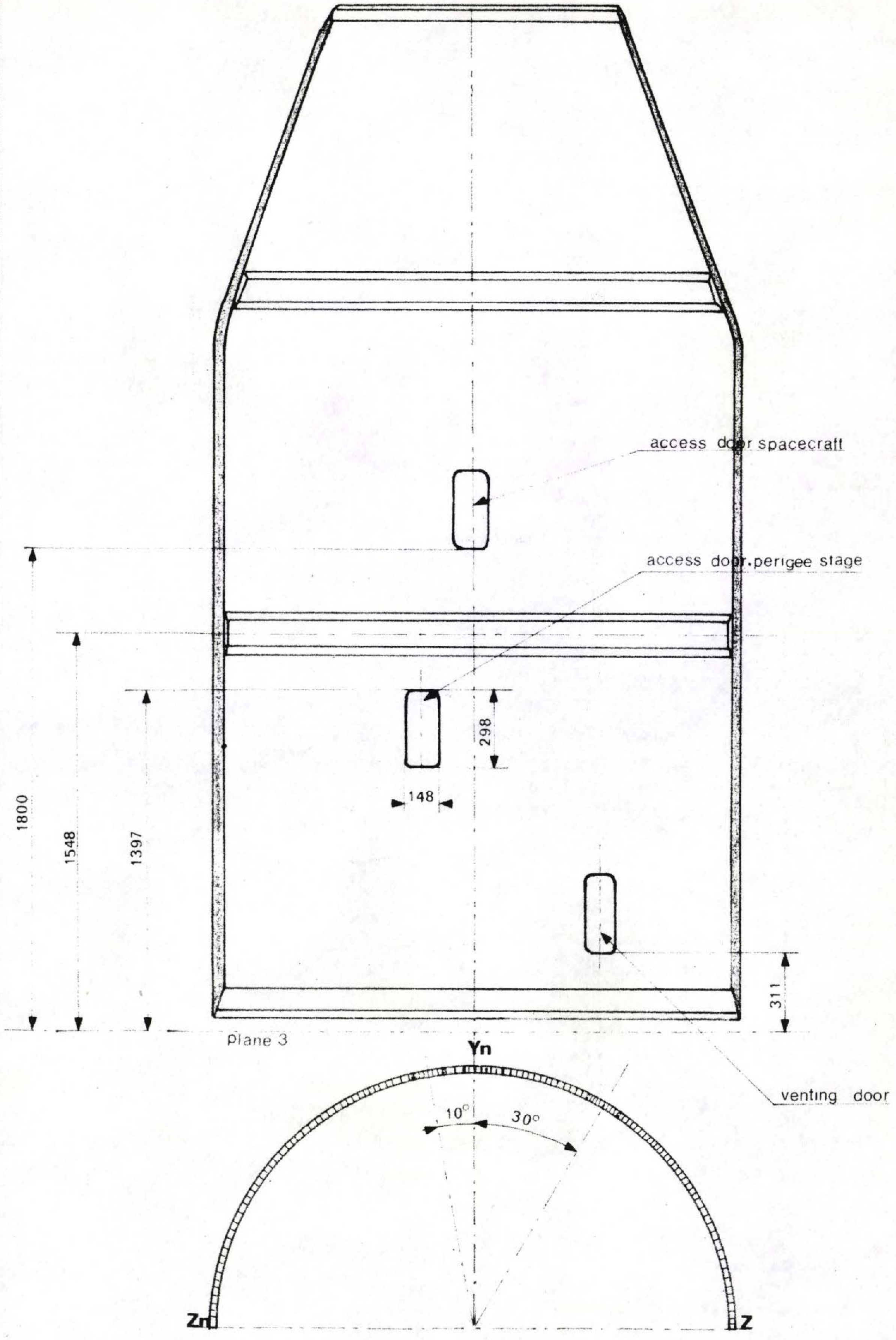
Page
Figure 4·22
AL.0


access door spacecraft umbilical
access door.perigee stage umbilical
external umbilical plug
1800
1548
1397
298
148
311
plane 3
Y
10°
30°
Z
Zn

Dessiné par.
Vérifié par:

Titre:
EUROPA 1 & 2
Doors . Y half fairing

Page
Figure 4_23
AL.0



Dessiné par: Hamard
Vérifié par:

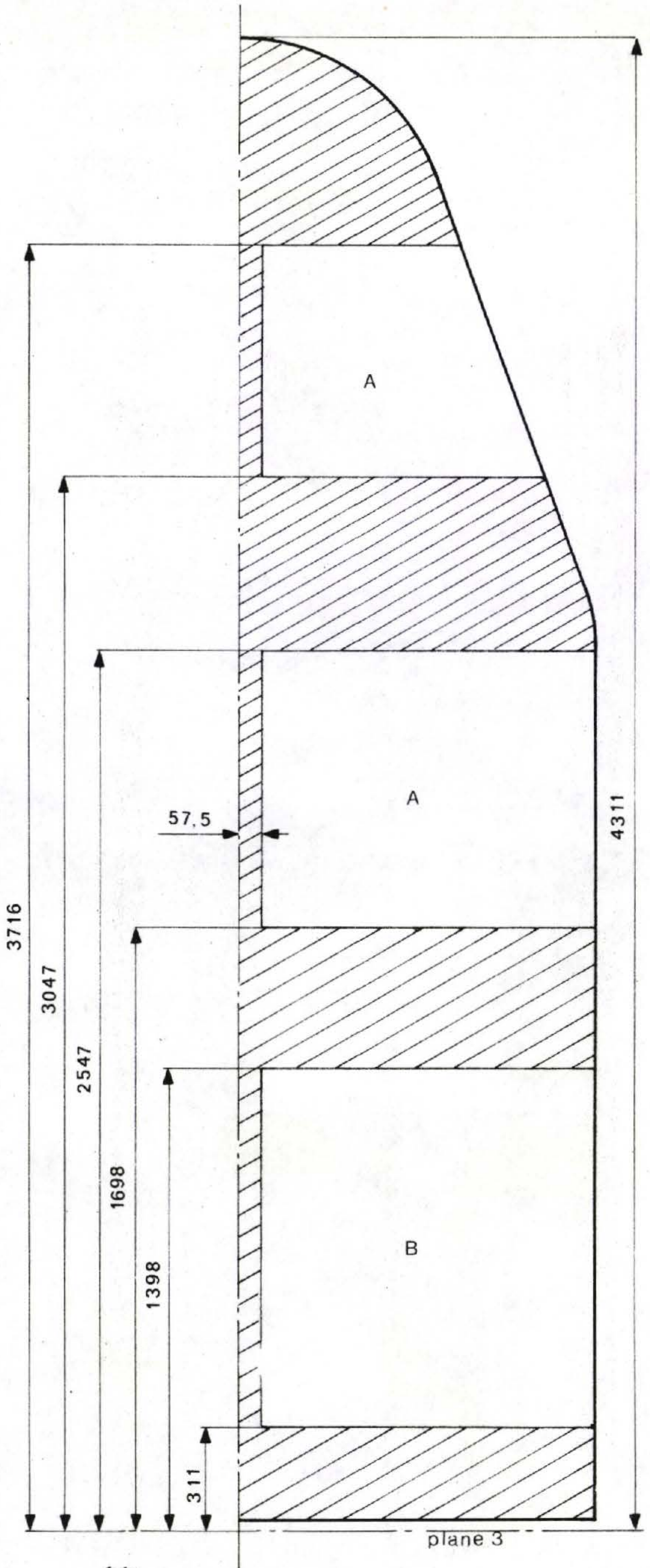
Titre. **EUROPA 1 & 2**

Doors .Yn half fairing

Page:

Figure: 4.24

AL.0



▨ no doors allowable

A openings with, screwed and sealed doors allowable

B openings with clip door allowable

Dessiné par:

Vérifié par:

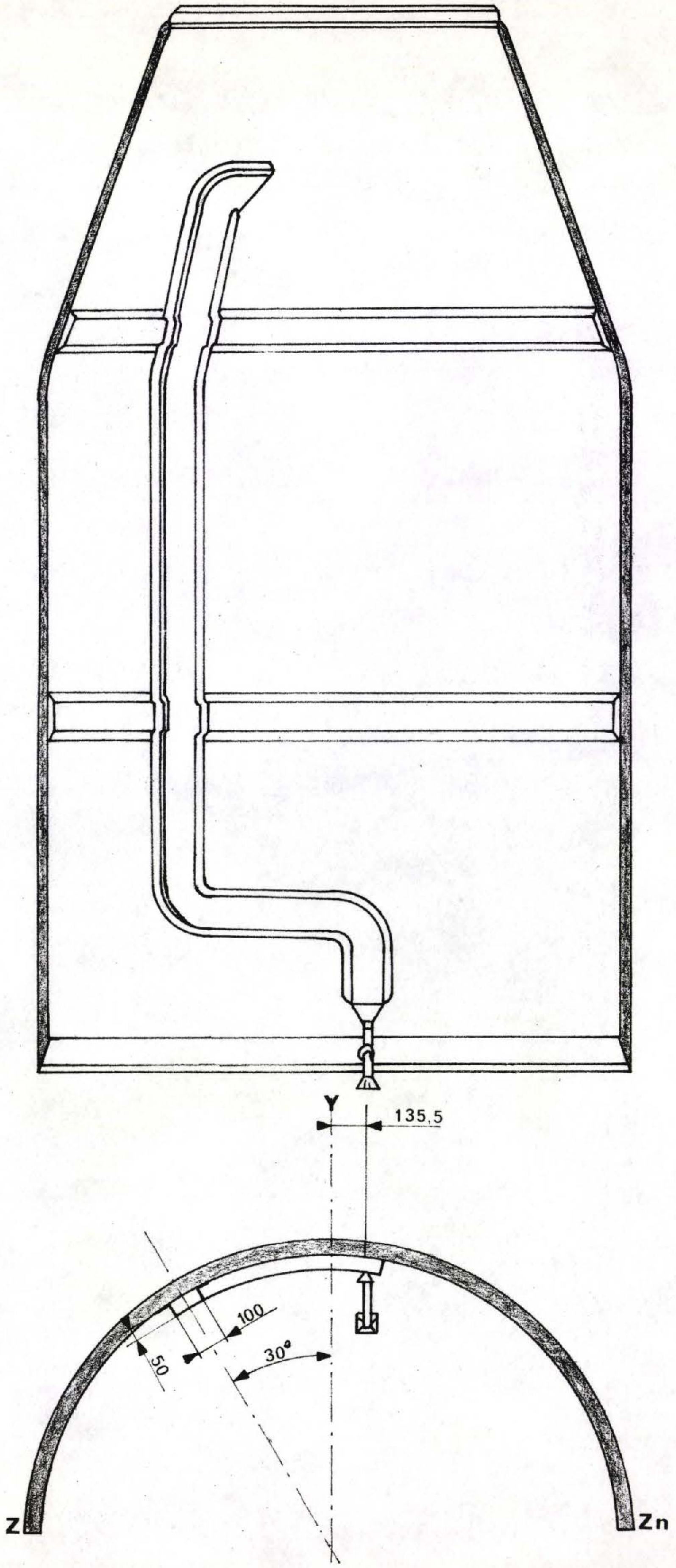
Titre: **EUROPA 1 & 2**

Permissible areas for doors

Page:

Figure: 4.25

AL.0



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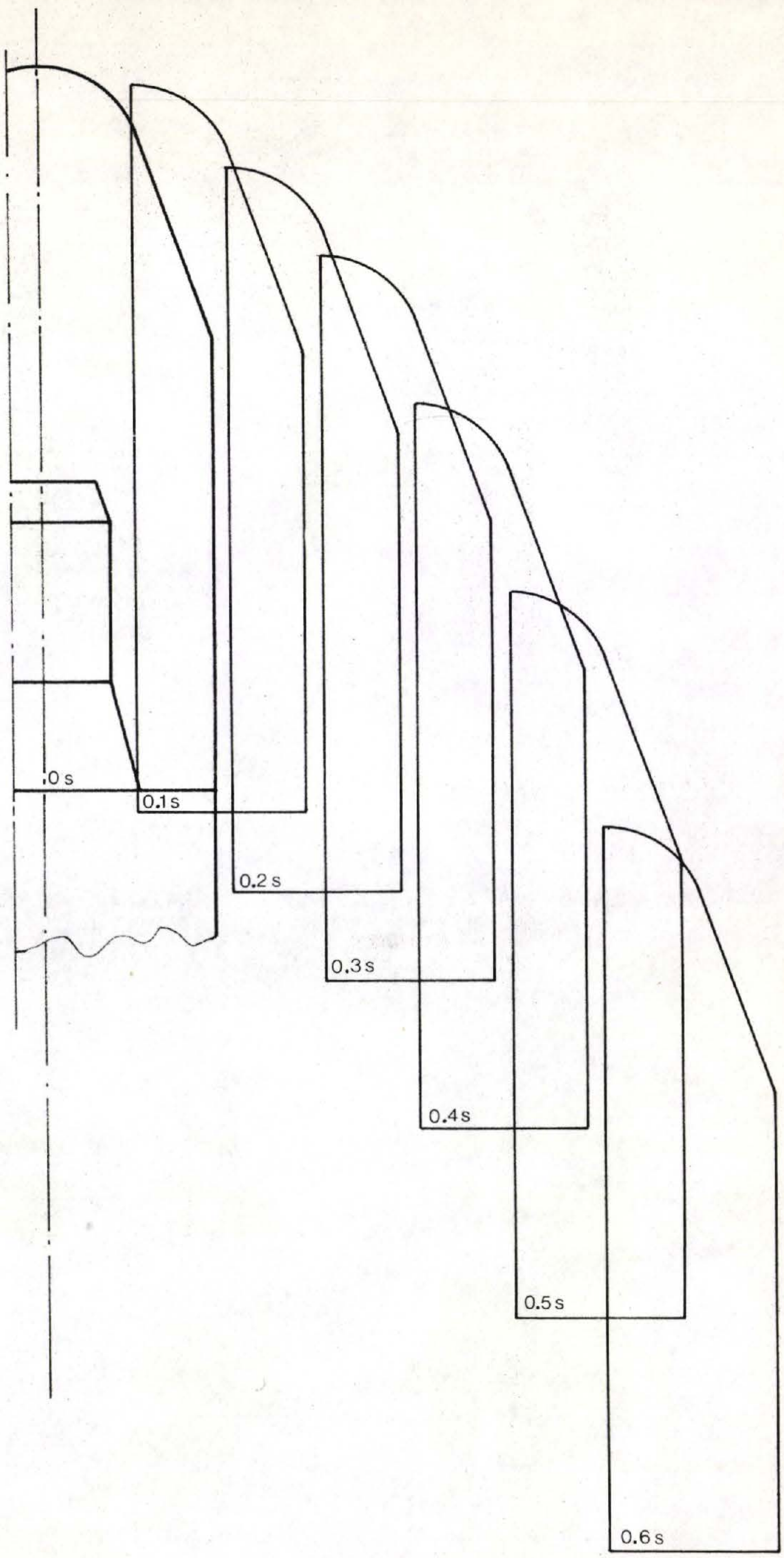
Vérifié par:

Titre: **EUROPA 2**

Ventilation and ducts

Page:
Figure: 4.26
AL.0



Lateral velocity : 5.5 m/s

Vehicle longitudinal acceleration : 25 m/s²

Dessiné par:

Vérifié par:

Titre:

EUROPA I & 2

Fairings jettisoning trajectory

Page:

Figure: 4.27

AL.0

5. MECHANICAL DESIGN ENVIRONMENT AND TEST REQUIREMENTS

5.1 General discussion

5.2 Spacecraft loads during flight

5.3 Combined loads

5.4 Flight acceptance and qualification test levels

5.5 Thermal environment

CHAPTER V - MECHANICAL DESIGN ENVIRONMENT AND TEST REQUIREMENTS

5.1 General discussion

This chapter provides a description of environmental conditions encountered by the spacecraft during flight, and of recommended qualification and acceptance tests to which the spacecraft should be submitted.

The information contained in para. 5.2 is based partly on theoretical calculations, partly on measurements performed during F4 to F9 launches of Europa I vehicle; additional measurements performed during 3rd stage static tests and perigee stage flight on the Diamant B launcher have also been considered. The present state of development does not allow the provision for the moment of a complete set of data, namely for vibrations created by the perigee motor and for acoustical environment.

To avoid dynamic coupling between the low frequency vehicle and spacecraft modes, the stiffness of the spacecraft structure should be initially designed to produce fundamental frequencies above 30 Hz in the thrust and lateral axis, for Europa I or Europa II payloads, rigidly mounted at the vehicle payload separation plane.

5.2 Spacecraft loads during flight

5.2.1 Steady state acceleration

5.2.1.1 Longitudinal acceleration

A typical time history of the longitudinal steady state acceleration is given in fig. 3.9, the flight of the first three stages being valid for both Europa I and Europa II.

For Europa I the maximum value of acceleration occurs at the end of first stage propulsion. Assuming all the upper stage tanks completely filled, which is the normal case, the acceleration varies from 64 to 68 m/s^2 for a payload varying from 1250 kg to 300 kg.

For Europa II the value of acceleration at the end of 1st stage propulsion can be considered as independent of the payload and equal to 65 m/s^2. The maximum steady state acceleration occurs at the end of the 4th stage propulsion. The maximum value of the thrust is 49,000 N and occurs near the end of burning. The empty perigee stage mass being 105 kg, and M being the payload mass, the maximum acceleration is given by :

$$(5.1)\ \gamma\ (m/s^2) = \frac{49{,}000}{105 + M(kg)}$$

5.2.1.2 Lateral acceleration

In most cases the steady state lateral acceleration is small (i.e. < 0.1 g).

During first stage flight, the maximum steady lateral acceleration of about 0.3 g occurs at the time of peak aerodynamic pressure and is caused by a steady wind.

At the end of first stage flight, lateral loads are produced by the deflection of the motors, which balances any asymmetries during thrust decay. A 1° deflection is considered as a maximum; it corresponds to an acceleration of 0.3 g.

5.2.2 Accelerations caused by spin (Europa II only)

The vehicle is spun immediately after 3rd stage-perigee separation by four (or two) spinning rockets.

The resulting nominal angular acceleration is given by :

$$(5.2)\ \dot{\omega}\ (\text{rps}^2) = 2{,}5 \cdot \alpha \cdot \frac{118}{63 + I(\text{m}^2.\text{kg})} \qquad (\text{at} \pm 5\ \%)$$

I being the moment of inertia of the Europa II payload (see § 4.1.3.2).

α = 1 if 4 spinning rockets are used (nominal case)
α = 0,5 if 2 spinning rockets are used.

As the maximum value of angular acceleration differs by only 5 % from the above nominal value, a distinction between maximum and nominal values is unnecessary.

If R is the maximum distance of a point of the payload to the rotation axis, the tangential acceleration is :

$$(5.3)\ \gamma t(\text{m/s}^2) = 2\pi R \dot{\omega} = 5 \cdot \pi \cdot R_{(\text{m})} \alpha \cdot \frac{118}{63 + I(\text{m}^2.\text{kg})}$$

The resulting final spinning velocity is given by :

$$(5.4)\ \omega\ (\text{rps}) = \dot{\omega} \cdot \Delta t \qquad (\text{at} \pm 10\ \%)$$

where Δt is the burning time of the spinning rockets, whose nominal value is 0.8 s (see § 2.3.4)

The radial acceleration is

$$(5.5)\ \gamma\ r(\text{m/s}^2) = (2\pi\omega)^2 R = (2\pi\dot{\omega} \cdot \Delta t)^2 \cdot R$$

5.2.3 Sinusoidal vibrations*

5.2.3.1 Longitudinal

Lift-off, thrust build-up and vehicle release induce longitudinal oscillations (± 0.2 g measured on F9).

During transonic buffeting, lasting from about 53 to 60 sec. a vibration level of 0.2 g was measured in F8, at the first mode frequency.

'Pogo' oscillations have been recorded during first stage propulsive flight between 110 and 140 sec after lift-off and at a frequency of about 13.5 Hz corresponding to the first longitudinal mode of the vehicle. The highest amplitude recorded to date in the payload compartment was ± 0.5 g.

At first/second stage separation a computation for F9 resulted in a short oscillation of ± 0.7 g at 17 Hz. During F7, F8 and F9 the maximum value recorded at about this frequency was ± 0.5 g

In F7, at fairing jettisoning a short oscillation of 0.75 g at 50 Hz was measured.

During all flights of the 2nd stage an axial oscillation was detected at a frequency varying from 21 to 31 Hz. The measured peak amplitude of this oscillation was approximately ± 0.1 g.

At F7 second stage cut-off an oscillation of 1 g at about 50 Hz was measured.

The second/third stage separation is assisted by raising the pressure of the interstage. The sudden release of the tension thus created at the time of ignition of the explosive bolts induces longitudinal oscillations whose computed level is ± 7 g at a frequency of 40 Hz but this level is greatly dependent on the hypothesis made about the forcing functions.

In F7 and F8 just before explosion of 3rd stage a transitory oscillation at about 40 Hz of ± 2 g has been recorded; in F9 a peak of about ± 3.5 g, with small oscillations of about 0.5 g lasting 0.3 sec., have been obtained.

In F9, during the only 3rd stage flight available, the amount of vibration was negligible (< 0.1 g).

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* The levels of vibration quoted are expressed in peak values, and correspond to the base of a Europa I payload, unless otherwise stated.

5.2.3.2 Lateral

During transonic buffeting, an oscillation identical to the longitudinal one (± 0.2 g at about 6.5 Hz) was observed in F8.

At the time of the maximum aerodynamic pressure (around 75 s) the lateral acceleration of the F9 payload centre of gravity was theoretically evaluated in response to a 9 m/s sharp-edged gust at right angle of the longitudinal axis of the vehicle. This level of gust has a probability of 1 % of being exceeded. The computation was carried out in the most unfavourable conditions (head wind, vehicle flying at the limiting incidence). For F9 the curve is given in fig. 5.1; the maximum level of the oscillation is ± 1.3 g. This level has not so far been obtained in flight.

During F7 and F8 the maximum value recorded during the whole first/second stage separation process was ± 0.3 g at about 20 Hz.

During the F9 3rd stage flight, the only available up to now, the level recorded was negligible (± 0.1 g).

5.2.4 Random vibrations

There are two major sources of random vibrations in the structure : the operation of the engines (transmitted mainly by the air) and the turbulence of the boundary layer during the transonic phase.

Owing to the failure of the on-board vibration analyser in F9 and partly in F8, a complete spectrum of the random vibration in the spacecraft compartment is still not available.

The spectrum of vibrations measured during the 1st stage flight in F4 and F5 in an adapter located between the 3rd stage and the spacecraft is indicated in fig. 5.2. However the second and third stages were not fully representative of the Europa I launcher (dummy stages).

The analysis of vibrations of the F7 launch, which in many aspects reflects the Europa I conditions, is shown in the following table.

Table V-I

SUMMARY OF F7 TRIAL ANALYSIS

Period	160-290 Hz	290-510 Hz		510-915 Hz		915-1650 Hz	
		Time (s)	g^2/Hz	Time (s)	g^2/Hz	Time (s)	g^2/Hz
Longitudinal (X axis)							
Lift off	lost	5.9	8.10^{-5}	5.63	9.10^{-4}	6	1.10^{-4}
Transonic buffeting	"	51	8.10^{-5}	51.35	2.10^{-3}	51.5	3.10^{-4}
Fairing jettisoning	"	181.1	4.10^{-5}	180.5	4.10^{-4}	180.5	3.10^{-5}
2nd/3rd stage separation	"	255.7	3.10^{-4}	256	2.10^{-3}	255.8	5.10^{-5}
Last part of time history	"	335	4.10^{-5}	313.8	4.10^{-4}	308	5.10^{-6}
Lateral (Z axis)							
Lift off	lost	lost		lost		5.65	2.10^{-5}
Transonic buffeting	"	"		"		68	7.10^{-5}
2nd/3rd stage separation	"	"		"		255	7.10^{-5}

The results of the F8 launch are given in fig. 5.3 for longitudinal vibrations. The F8 vehicle was intended in some respect to simulate the F11 configuration (relatively heavy payload : 460 kg on the top of a long adapter : 2 m)

The results of the F9 launch are restricted to frequencies up to 50 Hz and they are also shown in fig. 5.3.

A static firing of the 3rd stage was carried out with an inert perigee stage and a technological capsule. The level of recorded vibrations (in fig. 5.4 and 5.5) is not representative of the level obtainable in flight (3rd stage burns in vacuum), but these curves give an idea of the shape of the power density spectrum during the functioning of the 3rd stage. Fig. 5.4 corresponds to longitudinal vibrations from 2 to 200 Hz measured at the base of the technological capsule and fig. 5.5 to lateral vibrations from 2 to 2000 Hz measured at the base of the equipment bay.

The perigee stage of Europa II is also the 3rd stage of Diamant B, therefore the only information available is that recorded during the first two flights of this vehicle. During the first records of the Diamant B 3rd stage flight a relatively high vibration level produced by the perigee stage motor was recorded on the equipment bay support structure.

This vibration was generally random in nature, with several dominant frequencies present between 350 Hz and 600 Hz. Following peak values of these dominant frequencies have been recorded on the upper part of the structure :

in longitudinal direction : first flight = ± 3.5 g
second flight = ± 17 g

in lateral (tangential) direction : first flight = ± 2.3 g
second flight = ± 12 g.

Remark : The lateral (radial) direction has not been considered, owing to local vibrations of the structure.

5.2.5 Acoustic environment

A test was carried out during the F1 static test of the first stage above the stand. Fig. 5.6 shows a theoretical calculation of the acoustic noise level distribution along the vehicle in the following configuration :

- Curve 1 = 1st stage solo on the stand
- Curve 2 = " " " in transonic flight
- Curve 3 = multistage vehicle on the stand
- Curve 4 = " " in transonic flight.

The two measured values shown on the figure are in good agreement with curve 1; however the degree of confidence of these curves is not known.

5.2.6 Shock-environment

No in-flight data on the shock environment are available, at the level of Europa I and II payloads. However, it is expected that the structure will absorb most of these shocks, except for the vehicle-payload separation, during which 2 explosive devices operate the Marman belt (whatever the separation system considered).

5.3 Combined loads

During the various flight times, sinusoidal and random accelerations are superimposed on steady state accelerations. From para. 5.2 the following important loading cases have been identified :

For Europa I and II :

a) Maximum dynamic pressure. In the case of the maximum aerodynamic pressure coincident with a 9 m/s gust high lateral loads are experienced. Fig. 5.7 gives the evolution versus time for resulting longitudinal and lateral loads computed at limiting incidence for F9.

b) End of 1st stage propulsion, corresponding to a high longitudinal acceleration.

c) 2nd/3rd stage separation, corresponding to longitudinal tension loads.

For Europa II only :

d) End of perigee spinning, corresponding to maximum tangential and radial accelerations.

e) End of perigee propulsion, corresponding to maximum radial and longitudinal accelerations.

As has been seen in para 5.2 some of these loads are accurately known (e.g. those depending on the thrust of the engines), some are the result of computations corresponding to design cases (gust, longitudinal oscillations at 2nd-3rd stage separation), some are the result of measurements for which the confidence level is variable, depending on the number of measurements and on the degree of representativity of the measuring conditions.

The following table gives a summary of the 5 different loading cases; a safety margin has been added in order to obtain the limit load, which can be considered as a maximum, not to be exceeded in flight. It must be noted that these values are to be used for an initial design : the accelerations levels are dependent to some extent upon the mass and stiffness distribution of the spacecraft itself, and these values may be refined when the coupled spacecraft-launcher loading computer studies are performed in each particular case.

TABLE V-2

COMBINED LOADS

(VALUES ARE GIVEN IN G O-PEAK)

<table>
<tr><th rowspan="2">Flight event</th><th colspan="3">Steady acceleration load</th><th colspan="3">Sinusoidal load</th><th colspan="3">Quasi-steady limit load</th></tr>
<tr><th>lat.</th><th colspan="2">long.</th><th>lat.</th><th colspan="2">long.</th><th>lat.</th><th colspan="2">long.</th></tr>
<tr><td>Europa I and II</td><td></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td>a) Maximum dynamic pressure</td><td>$0.3^{(2)}$</td><td colspan="2">1.8</td><td>$1.3^{(1)}$</td><td colspan="2">0</td><td>1.8</td><td colspan="2">2</td></tr>
<tr><td>b) End of 1st stage propulsion</td><td>0.3</td><td colspan="2">6.7</td><td>0</td><td colspan="2">0</td><td>0.3</td><td colspan="2">7</td></tr>
<tr><td>c) 2nd/3rd stage separation</td><td>0</td><td colspan="2">0</td><td>0</td><td colspan="2">± 3.5</td><td>0</td><td colspan="2">±3.5</td></tr>
<tr><td>Europa II only</td><td>tang^1</td><td>radial</td><td>long^1</td><td>tang^1</td><td>radial</td><td>long^1</td><td>tang^1</td><td>radial</td><td>long^1</td></tr>
<tr><td>d) End of spinning</td><td>$11.2^{(3)}$</td><td>$11.3^{(4)}$</td><td>0</td><td>0</td><td>0</td><td>0</td><td>11.2</td><td>11.3</td><td>0</td></tr>
<tr><td>e) End of perigee propulsion</td><td>0</td><td>$11.3^{(4)}$</td><td>$10.5^{(5)}$</td><td>0</td><td>0</td><td>0</td><td>0</td><td>11.3</td><td>10.5</td></tr>
</table>

Important: Figures quoted in d) and e) are given as an example and correspond to the PAS mission only : $M = 360$ kg, $I = 55$ m^{2}kg, $R = 0.716$ m, $\alpha = 1$, $t = 0.8$ s (Notation in § 5.2.1).

These figures must be computed again for each mission.

(1) Due to gust (computed)

(2) Computed

(3) Given by eq. (5.3) or proportional to $R\alpha(63 + I)$

(4) Given by eq. (5.5) or proportional to $R\alpha^2(63 + I)^2 \Delta t^2$

(5) Given by eq. (5.1) or proportional to $\frac{1}{105 + M\ (\text{kg})}$.

5.4 Flight acceptance and qualification test levels

5.4.1 General

This section outlines a series of flight acceptance and qualification environmental tests for spacecraft launched on Europa I or Europa II vehicles based on the existing philosophy of testing used during the development of the launcher. In the following paragraphs, the following definitionswill be used :

- limit load : maximum load which a structure is expected to experience. When the variance of the statistical load distribution is known, the limit load is taken as the 3σ value.

- proof load : load during application and after the removal of which the structure shall not sustain any permanent deformation. The proof load is obtained by multiplying the limit load by the proof safety factor (Jp).

- ultimate load : load under which no rupture or collapse of the structure must occur. The ultimate load is obtained by multiplying the limit load by the ultimate safety factor (Ju).

Remark : proof load and ultimate load must not be confused with proof failure load and ultimate failure load which are the loads at which permanent deformation and rupture, respectively occur.

The following safety factors are adopted :

Table - V-3

SAFETY FACTORS FOR EUROPA I AND EUROPA II

Static firing, start and first 30 seconds flight		Flight after first 30 seconds	
Jp	Ju	Jp	Ju
1.25	1.50	1.10	1.25

These are the minimum safety factors the spacecraft designers must meet.

Recommended tests are the following :

- Combined loading test (qualification only)
- Sinusoidal vibration tests (qualification and acceptance)
- Random vibration tests (qualification and acceptance)
- Acoustic noise test (optional)
- Shock tests (qualification only).

5.4.2 Combined loading tests

For the qualification test, the loading cases are chosen amongst the more severe limit loads, obtained in table V-2 above. The levels to be applied are those corresponding to the ultimate load as defined in para. 5.4.1. The sinusoidal oscillations (permanent or transitory) are thus simulated by a permanent load, but only at the level corresponding to each loading case.

Tests can be performed by a static test or on a centrifuge.

The duration of the test is one minute. The tolerances and mounting of spacecraft for centrifuge testing should be performed according to method 513 of Military Standard 810 B, Environmental test methods, dated 15th, June 1967, and revised (Notice 1) on 20th October 1969.

5.4.3 Sinusoidal vibration tests

These tests are to be performed for qualification and acceptance. The levels given in the table V-4 below for acceptance are considered as limit loads as defined in para 5.4.1 ; it can be seen from figs 5.8 and 5.9 that owing to the poor knowledge of environmental vibratory conditions a safety margin of about 100 % has been added. The limit load has been multiplied by 1.5 to obtain the qualification levels.

The frequency sweep has been limited to 100 Hz, the vibration levels above this value being covered by the random vibration test. In these tests the spacecraft has to be mounted on the vibratory plate of the shaker in the same way as it will be mounted on the launch vehicle.

When it can be shown by a spacecraft/vehicle dynamic analysis that the spacecraft/attachment fitting assembly would be tested with above levels to unrealisitic conditions, the input level can be reduced at the resonance of the hard mounted spacecraft/attachment fitting assembly to simulate more realistically flight loading conditions.

Table - V-4

SINUSOIDAL VIBRATION TESTS FOR EUROPA I AND II

	Qualification	Acceptance
Frequency	Sinusoidal Test Levels (0-P) in Lat. Direction	
5 - 10 Hz	const. amp. to 2 g at 10 Hz	const. amp. to 1.3 g at 10 Hz
10 - 100 Hz	2 g	1.3 g
Duration	one sweep at 2 oct./min.	one sweep at 4 oct./min.
	Sinusoidal Test Levels (0-P) in Axial Direction	
10 - 20 Hz	const. amp. to 2.5 g at 20 Hz	const. amp. to 1.7 g at 20 Hz
20 - 100 Hz	2.5 g	1.7 g
Duration	one sweep at 2 oct./min.	one sweep at 4 oct./min.

5.4.4. Random vibration tests

These tests are to be performed for qualification and acceptance. The levels given in table V-5 are considered as limit loads; they have been multiplied by $(1.5)^2 = 2.25$ to obtain the qualification level; this coefficient is consistent with the one used for sinusoidal tests.

In these tests the spacecraft has to be mounted on the vibratory plate of the shaker in the same way as it will be mounted on the launcher vehicle.

Table V-5

RANDOM VIBRATION TESTS FOR EUROPA I

Europa I	Qualification	Acceptance
Frequency	PSD (g^2/Hz) in lateral direction	
20 - 300 Hz	+ 3 dB/oct.	
300 - 2000 Hz	0.01	0.0045
	($\simeq$ 4.3 g rms)	($\simeq$2.9 g rms)
Duration	4 min/axis	2 min/axis
	Psd (g^2/Hz) in longitudinal direction	
20 - 300 Hz	+ 3 dB/oct.	
300 - 2000 Hz	0.02	0.009
	($\simeq$ 6.1 g rms)	($\simeq$4.1 g rms)
Duration	4 min/axis	2 min/axis

RANDOM VIBRATION TESTS FOR EUROPA II

Europa II	Qualification	Acceptance
Frequency	PSD (g^2/Hz) in lateral direction	
20 - 300 Hz	+ 3 dB/oct.	
300 - 2000 Hz	0.02	0.009
	($\simeq$ 6.1 g rms)	($\simeq$4.1 g rms)
Duration	4 min/axis	2 min/axis
	PSD (g^2/Hz) in longitudinal direction	
20 - 300 Hz	+ 3 dB/oct.	
300 - 2000 Hz	0.04	0.018
	($\simeq$ 8.6 g rms)	($\simeq$5.8 g rms)
Duration	4 min/axis	2 min/axis

The acceleration levels are limited at 3 times the rms value.

5.4.5 Acoustic noise test

Acoustical testing is not normally necessary, but may be required in special instances, for some spacecraft components having a large surface area-to-mass ratio, or being microphonic.

Due to present lack of information, the following values already defined for similar launchers can be used.

Table V-6

ACOUSTIC NOISE TESTS FOR EUROPA I AND EUROPA II

	Qualification	Acceptance
Frequency (Hz)	Sound pressure level - (ref. 0.0002 dynes/cm^2)	
37,5 - 75	130	126
75 - 150	135	131
150 - 300	138	134
300 - 600	140	136
600 - 1200	141	137
1200 - 2400	138	134
2400 - 4800	134	130
4800 - 9600	129	125
Overall	146	142
Duration	1 minute	30 seconds

The test input tolerance is plus 4 db minus 2 db around the test specimen.

5.4.6 Shock tests

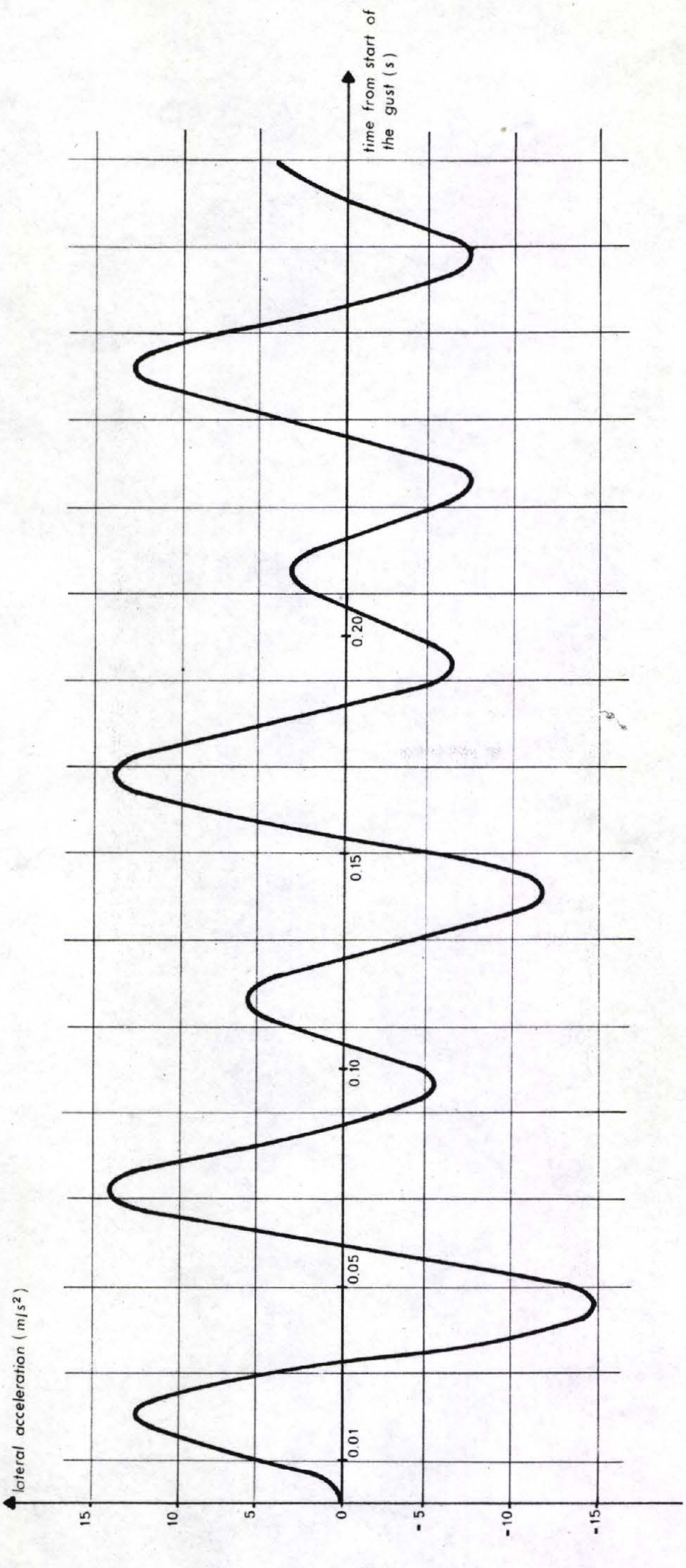
Shock tests are recommended only for qualification. The definition of the level and duration of the shock is extremely sensitive to the location of the measurement point; in addition this knowledge is not mandatory, the recommended test being to use a real Marman belt in a test on a flight-type attachment fitting. To perform such a test twice is considered sufficient.

5.5 Thermal environment

Fig. 5.12 shows a typical temperature profile during flight, measured at various points. In all cases the maximum increase of internal temperature during flight is less than 20° C (T6 sensor of fig. 5.12); this result has been verified many times in flight.

The absorptivity coefficient of the outer surface of the fairings is 0.3. The emissivity coefficient is 0.85 on the ground up to lift-off; but due to ablation of thermal coating during flight the final value is 0.90.

Unless otherwise requested, fairing ejection will occur some time after the theoretical free molecular heating rate for a flat plate normal to the free stream drops below 0.2 Cal/m^2.s (or 0.076 BTU/ft^2.s).



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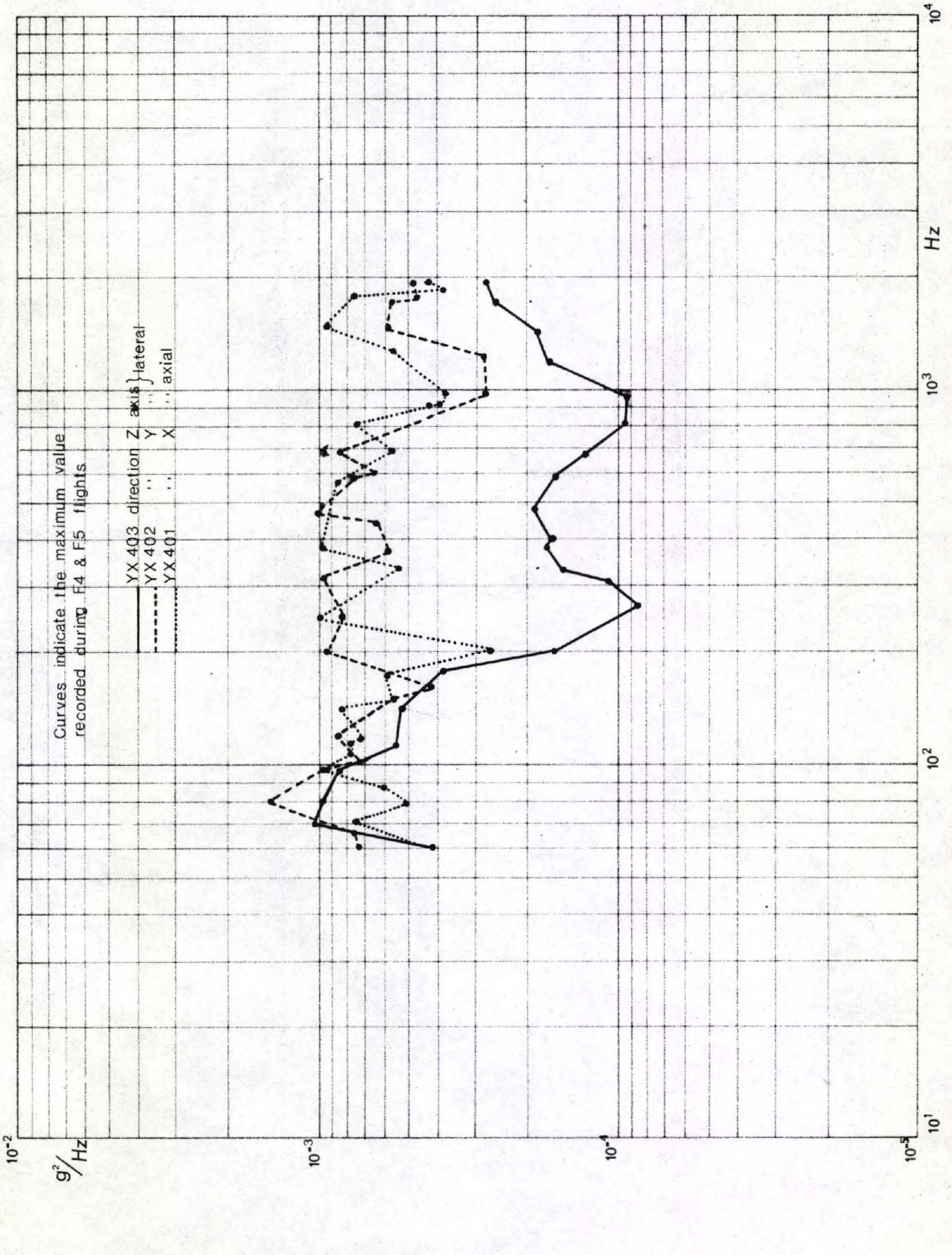
Vérifié par:

Titre: Initial transient lateral acceleration of payload (73 s ZST; computed value with head wind at the level of C.G. of F9 payload

Page:

Figure: 5.1

AL.0



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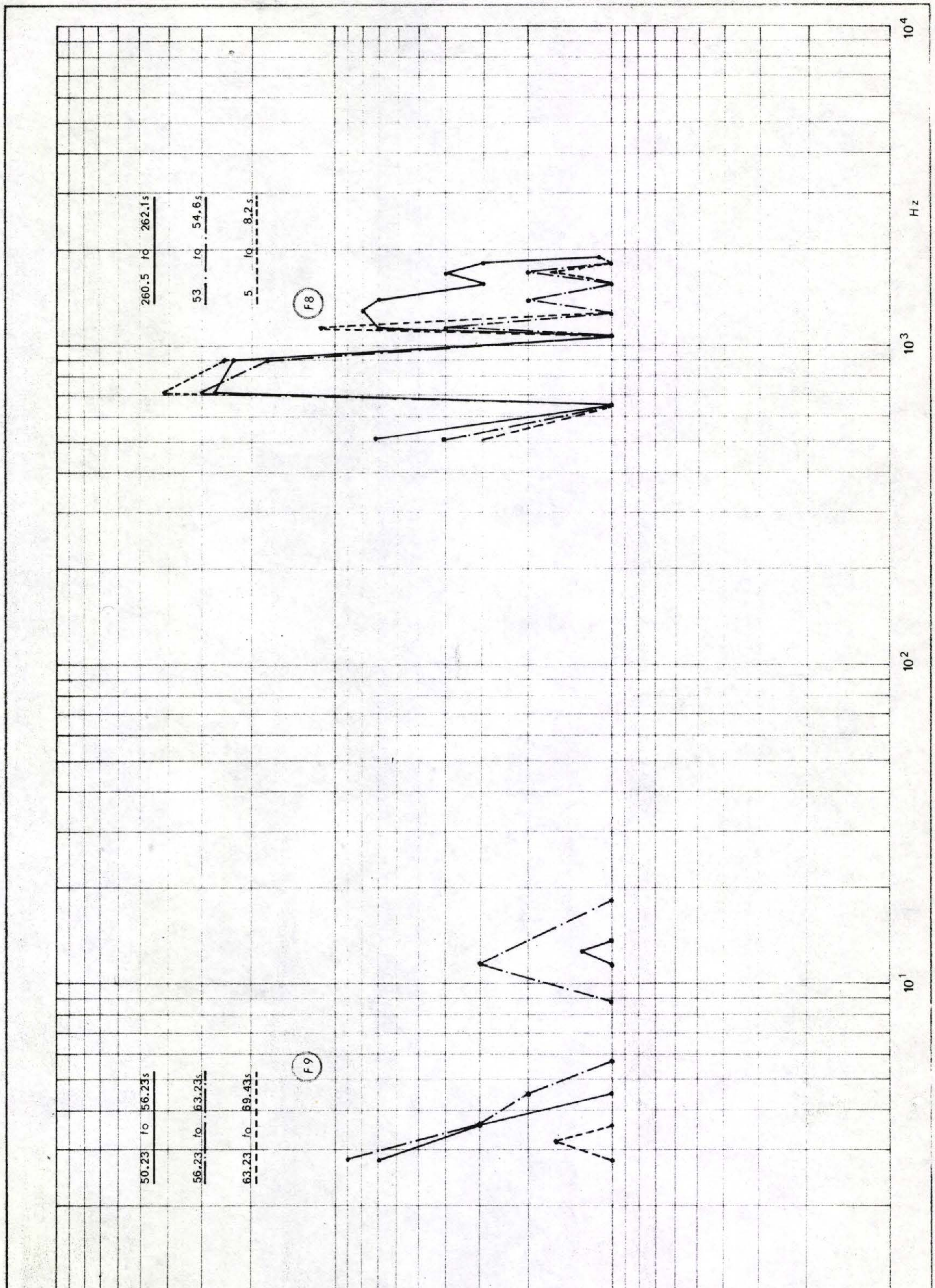
Titre
Power spectral density versus frequency achieved during F4 & F5

Page
Figure 5.2
AL.0



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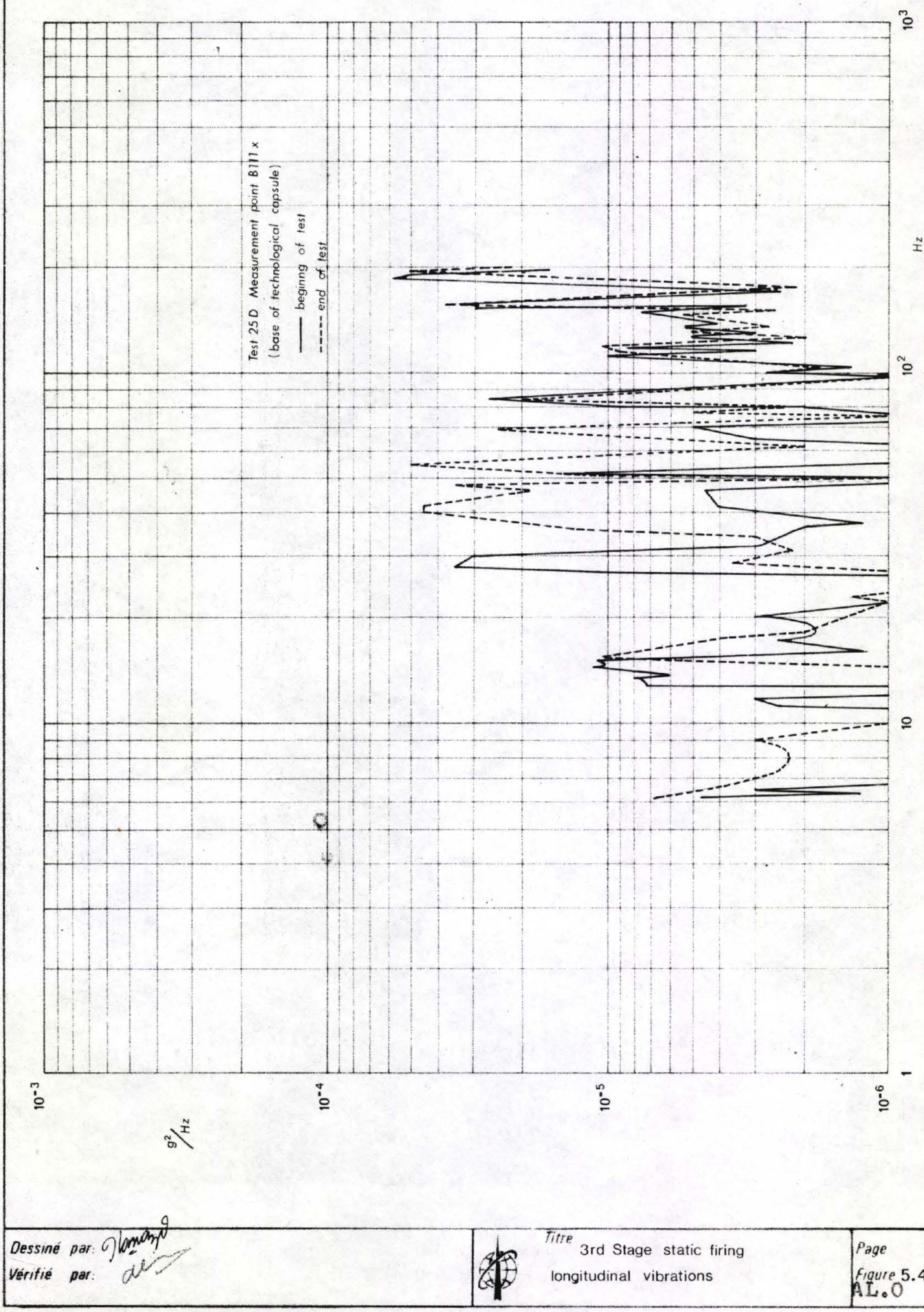
Titre
S.T.V. X axis vibration
measured during F8 & F9

Page
Figure 5.3
AL.0



Dessiné par:
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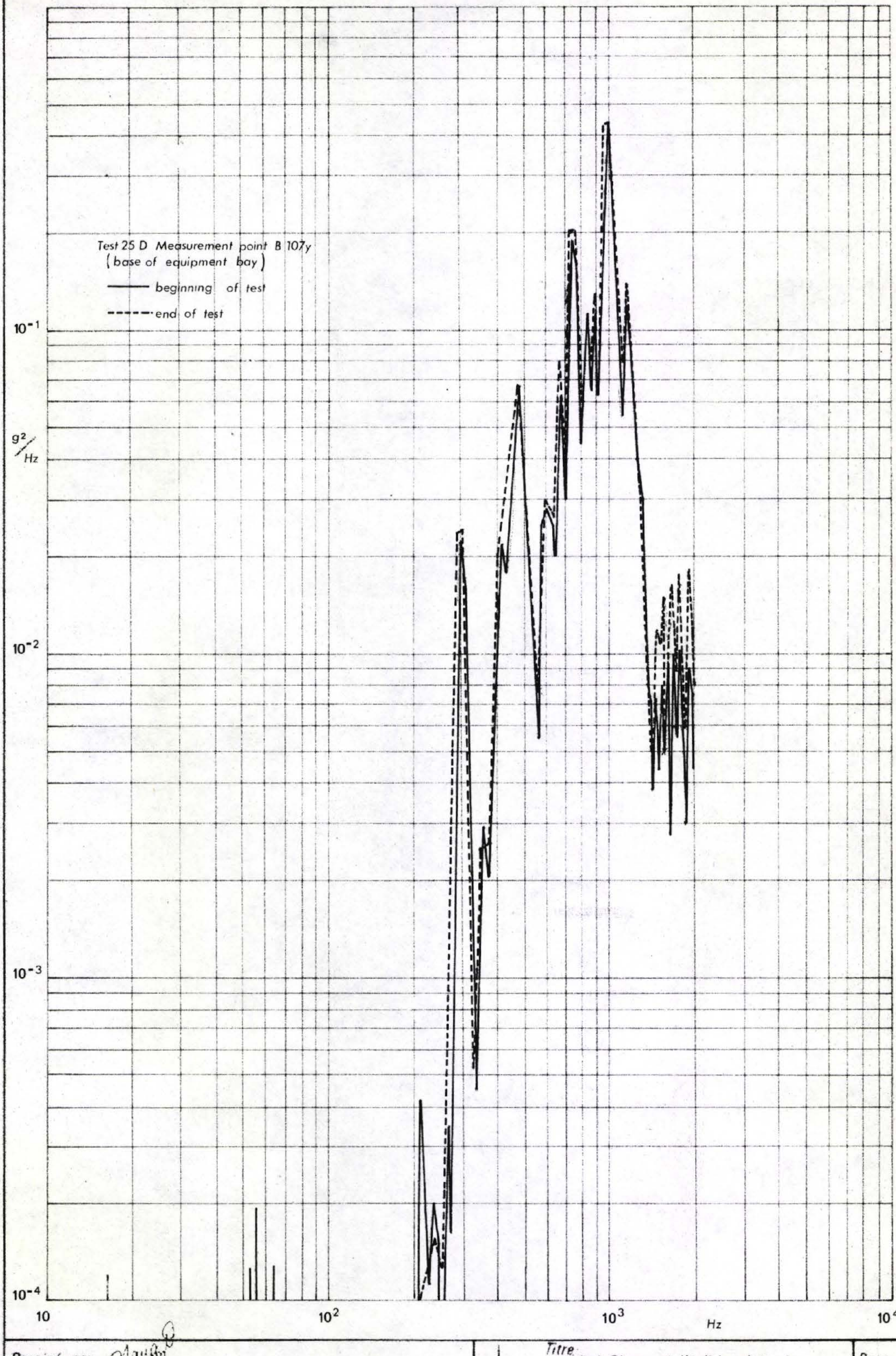
Titre
3rd Stage static firing
longitudinal vibrations

Page
Figure 5.4
AL.O



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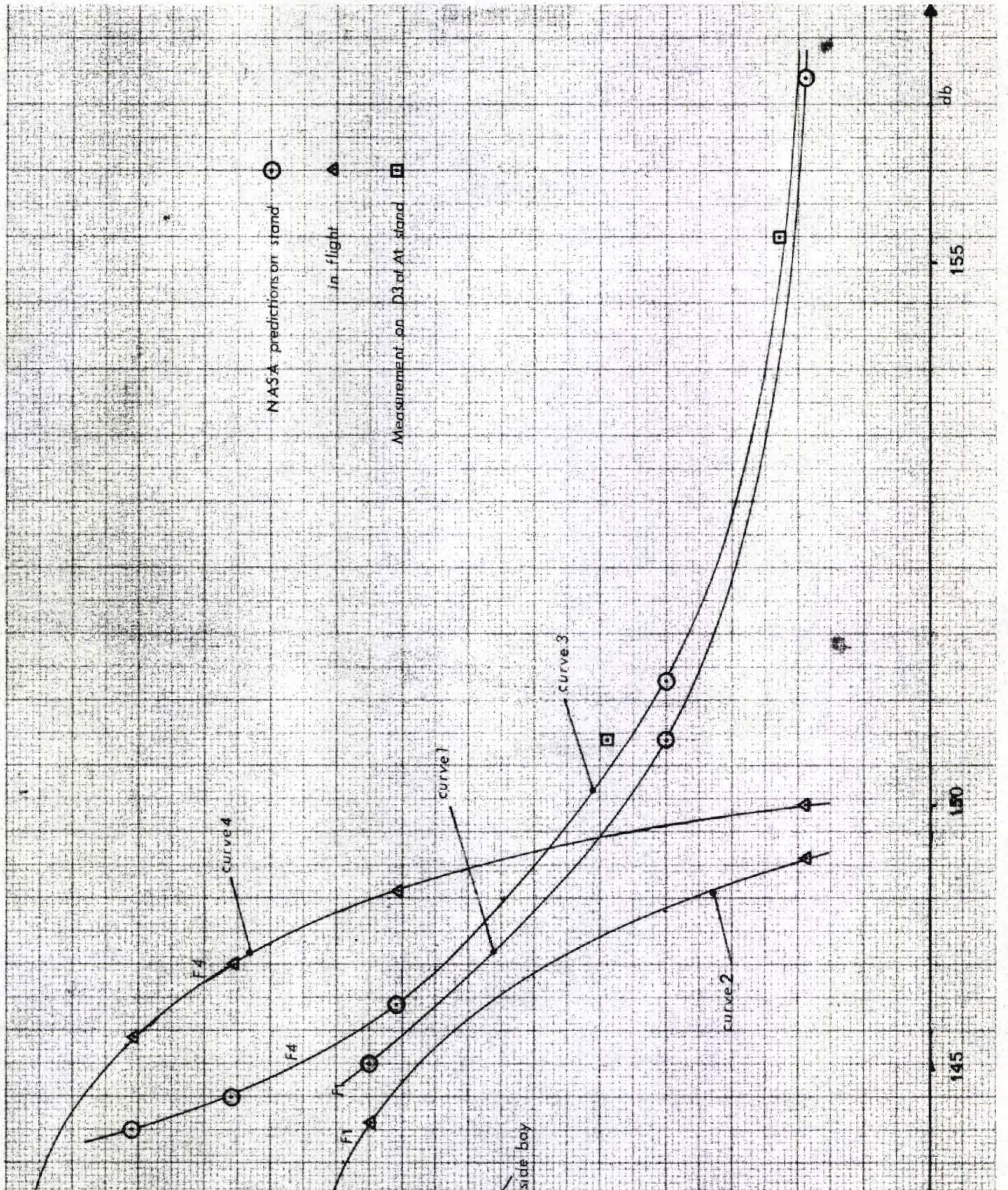
Titre: 3rd Stage static firing lateral vibrations

Page:

Figure 5.5

AL.0



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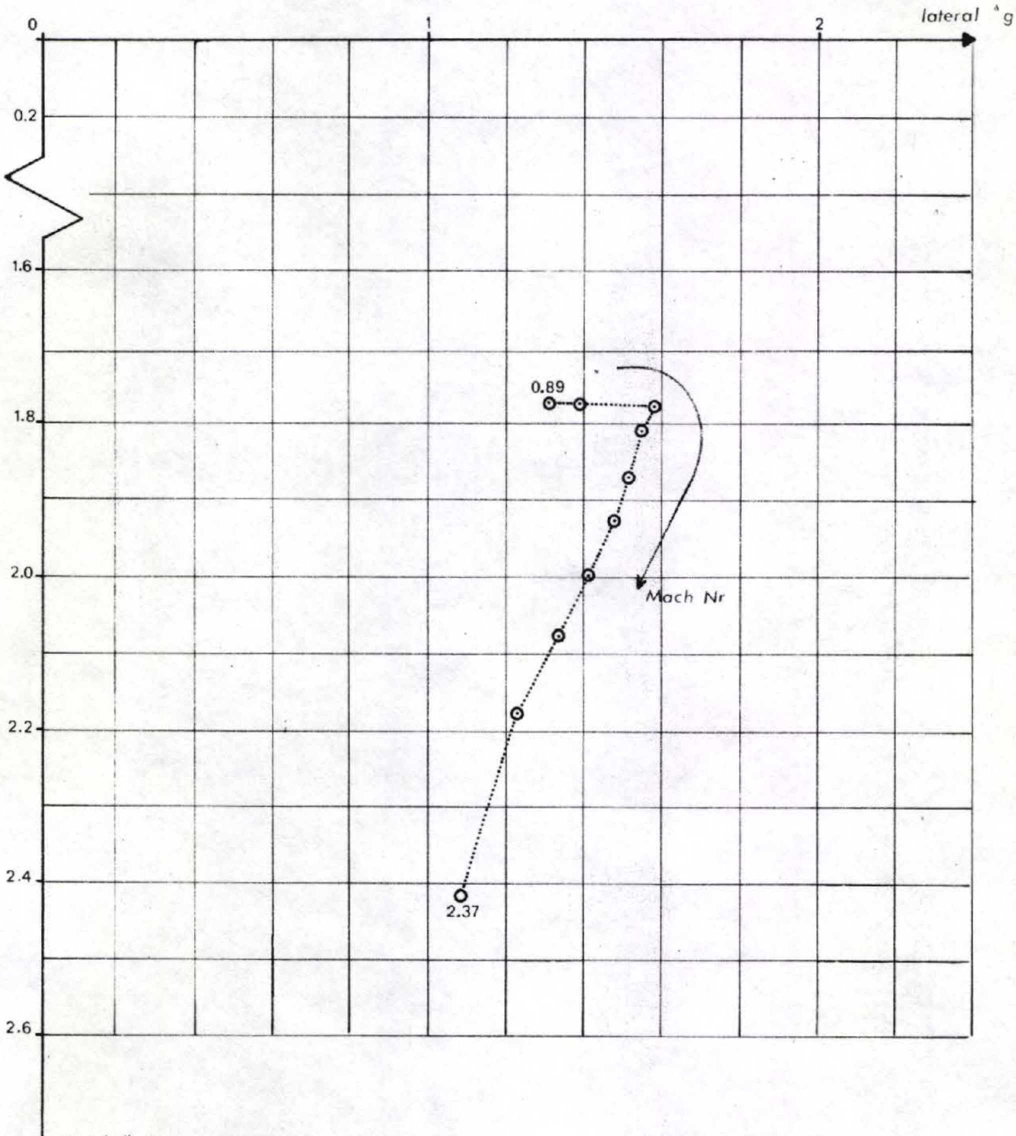
Titre: Variation of acoustic vibration excitation along vehicle

Page:
Figure: 5.6
AL.O



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Titre: Maximum payload acceleration for mach Nos 0.89- 2.37 computed at limiting incidence .F9.

Page:
Figure: 5.7
AL.O

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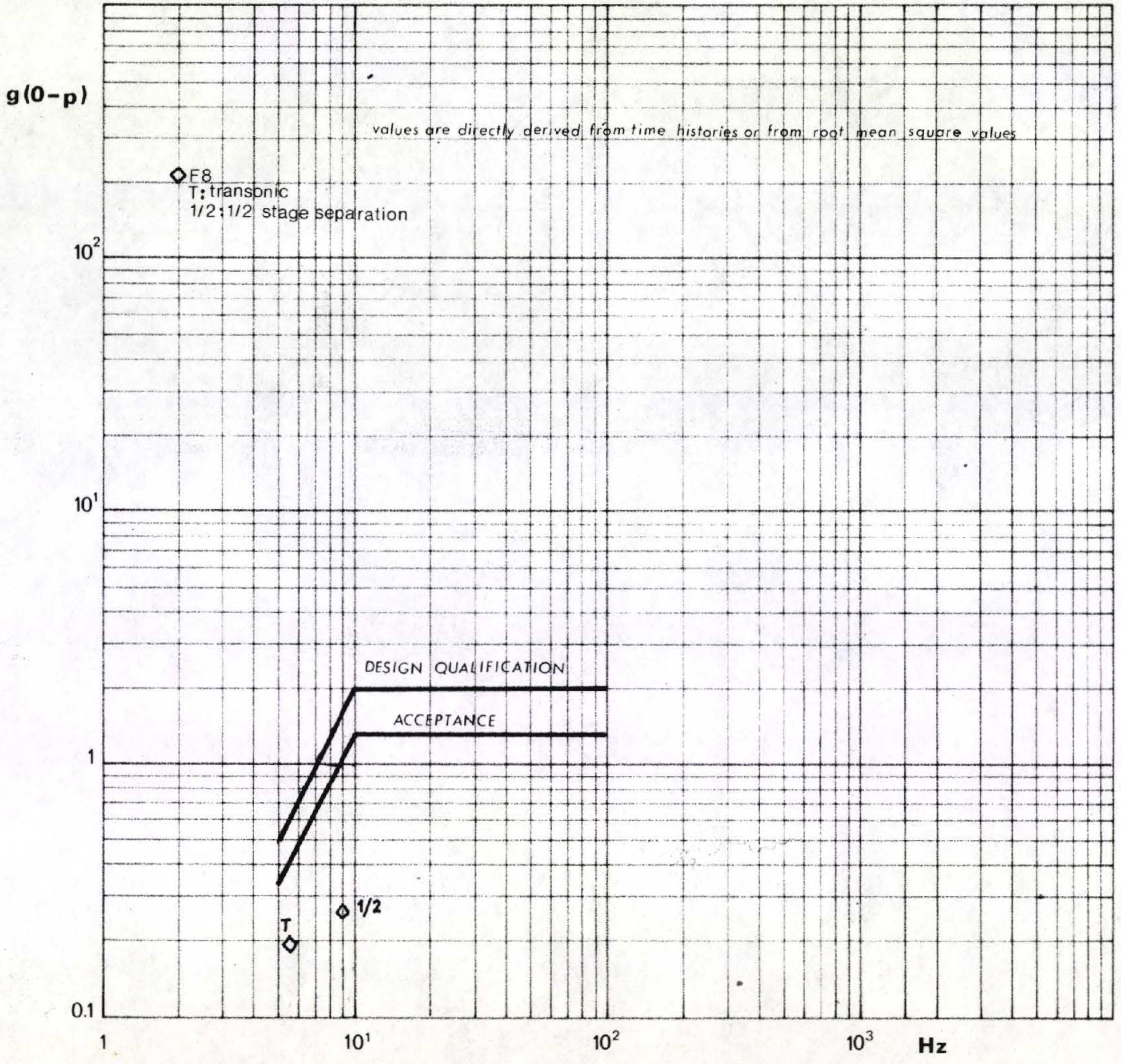
EUROPA I & 2

Sinusoidal test levels (lateral)

Page
Figure 5.8
AI.0



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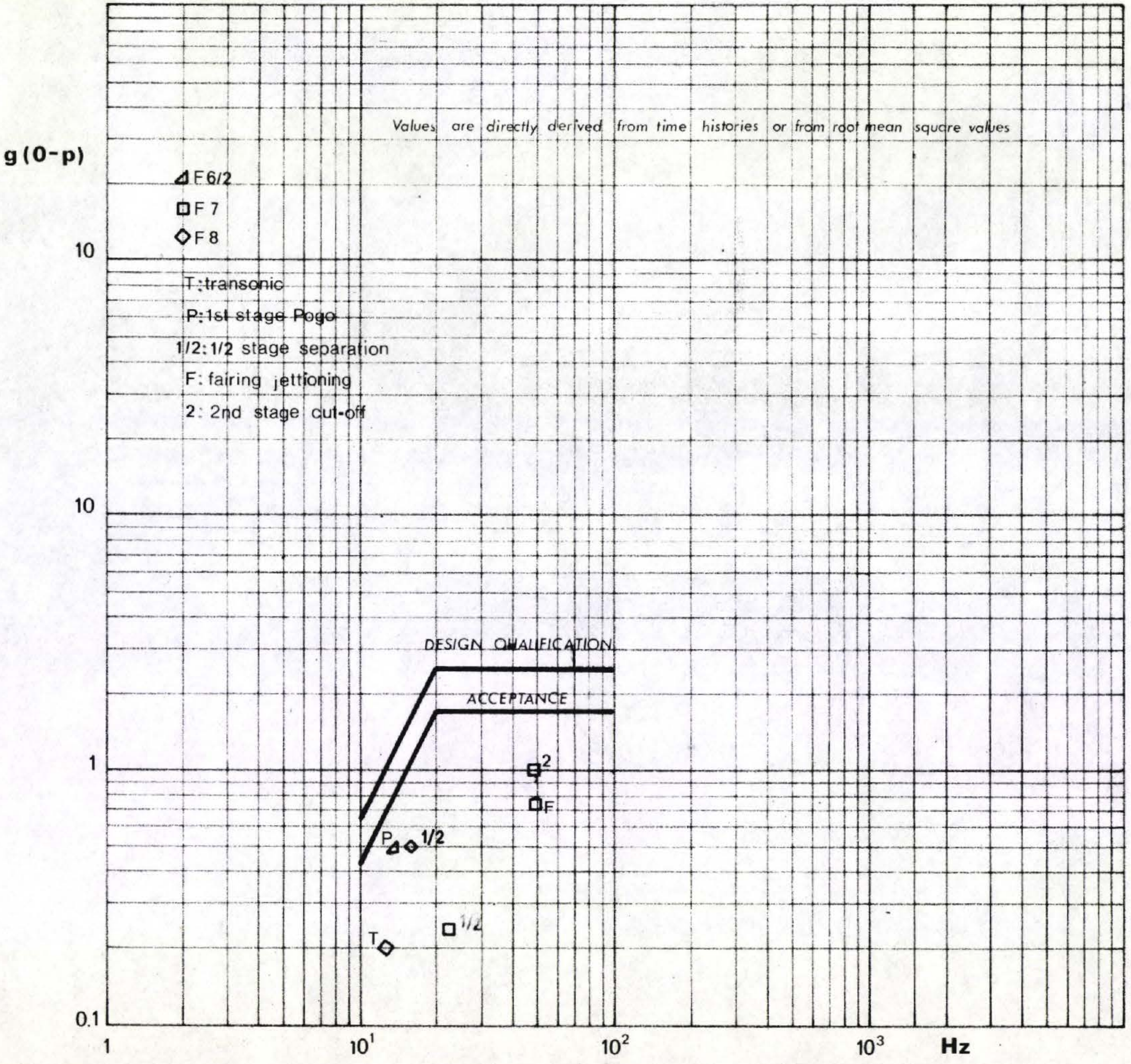
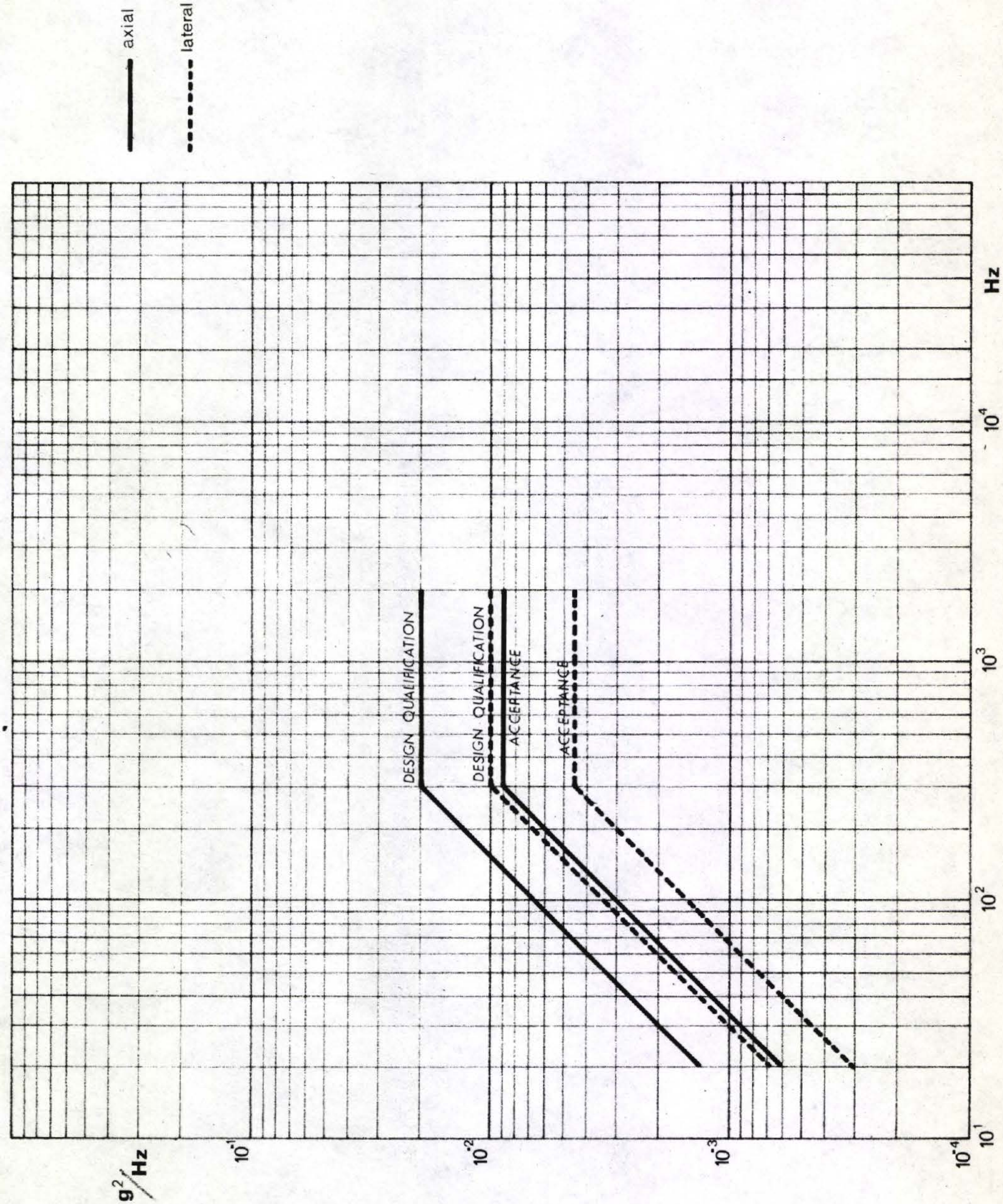


Titre:
EUROPA I & 2
Sinusoidal test levels (axial)

Page:
Figure 5.9
AL.8



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EUROPA I

Random test levels

Page:
Figure: **5.10**
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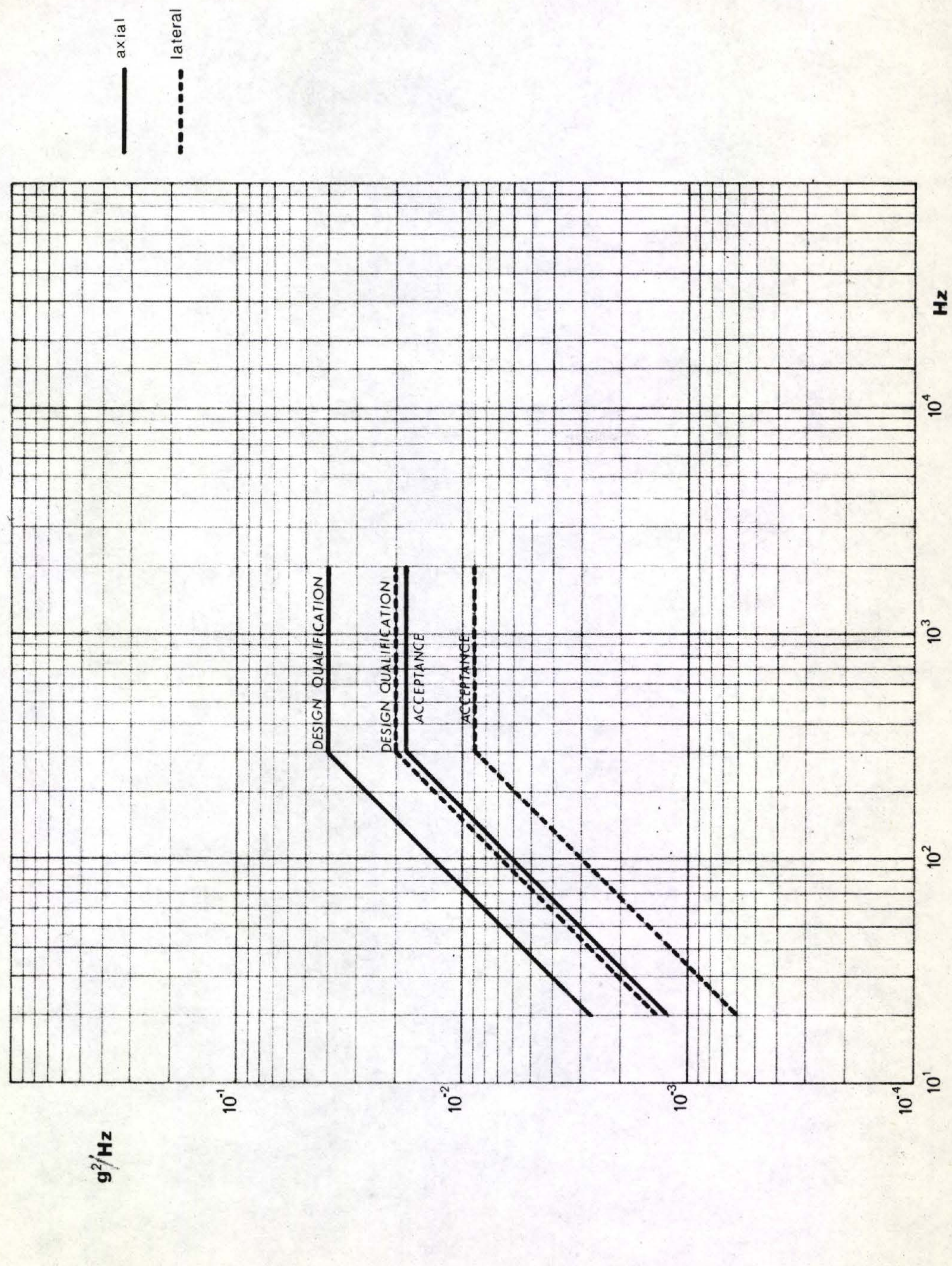

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EUROPA 2

Random test levels

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Figure 5.11
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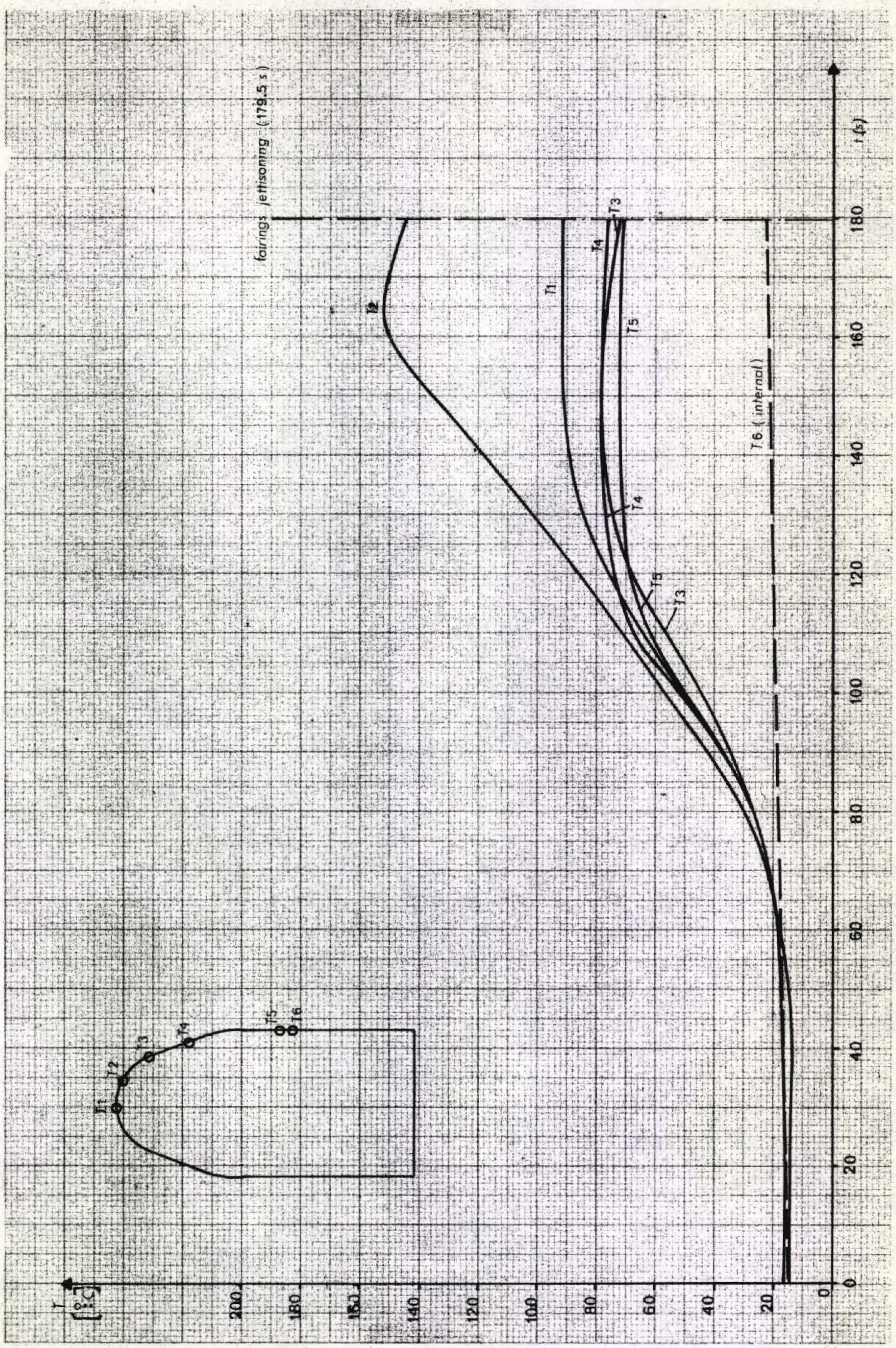

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Vérifié par		*Figure:* 5.12 AL.0

6. RANGE DESCRIPTION

6.1 Introduction

6.2 General Location of Facilities

6.3 Location of the Satellite Teams

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6.5 Detailed Description of the Satellite Preparation Building

6.6 Detailed Description of the Satellite Section of the Launch Centre

6.7 Detailed Description of the Satellite Section in the Forward Test Post

6.8 Description of the Tower Facilities used by the Satellite Team

6.9 Description of the Control Centre

6.10 Functional Equipment made available to the Satellite Team

6.11 Time Distribution

6.12 Stop Action Facilities and Ready Network

CHAPTER 6 - RANGE DESCRIPTION

6.1. INTRODUCTION

A detailed description of the facilities of the Guiana Space Centre (CSG) and the ELDO Equatorial Base (BEC) is given in various documents listed in the bibliography.

The purpose of this chapter is to group the essential information about the preparation and operation of satellites to be launched by EUROPA I and II vehicles.

The geographical situation of French Guiana and of the Kourou region is shown in figure 6.1.A. A map of the town of Kourou is given in 6.1.B.

.../...

6.2. GENERAL LOCATION OF FACILITIES

The general location of CSG and BEC facilities is given in figure 6.2.A. The activities of CSG and BEC are distributed over three zones:

- the Technical Centre
- the Launch sites
- isolated locations.

6.2.1. The Technical Centre (figure 6.2.B)

The Technical Centre is the focal point of CSG activities. It comprises:

- a CSG Administrative Building
- a technical building housing the offices of the principal CSG technical services
- a telecommunications building housing the CSG telephone and telex services and repair shops
- an optical building comprising a projection and conference room in addition to the usual laboratories
- the control centre
- the satellite preparation building
- the workshops (general ingineering)
- general stores.

6.2.2. The launch sites

There are three of these located along the RN 1 road between Kourou and Sinnamary. They are the sounding rocket launch site (ELFS) comprising the ERIDAN, VERONIQUE and VESTA launch areas, the DIAMANT launch site (ELD) and the EUROPA launch site (ELE) (see figures 6.2.c, 6.2.d, 6.2.e and 6.2.f). The ELE forms part of the ELDO Equatorial Base.

6.2.3. Isolated locations

To ensure optimum operating conditions for the BRETAGNE radar and for the telemetry a high location was sought giving direct line-of-sight of the launch complexes.

The site chosen was the Montagne des Pères. The facilities associated with the BRETAGNE radar and an infra-red theolodite have been set up on the northern ridge of this hill. The telemetry-associated facilities have been set up on its southern extremity.

A second infra-red theolodite has been sited on the Ile Royale, one of the Iles de Salut some 12 km off Kourou.

A rear station has been installed on the MONTABO, one of the hills overlooking Cayenne. This unit comprises a BRETAGNE radar and a telemetry station.

.../...

A DIANE/IRIS station has been constructed away from all radio-electrical interference on the northern boundary of the CSG along the road to Sinnamary.

In addition, a meteorological station has been built on the RN 1 not far from the Technical Centre and an explosives storage area has been set up, sited away from any habitations.

Finally, the BEC includes a TM station sited in Brazil at Fortaleza.

6.2.4. The industrial Zone

This is situated on the left bank of the Kourou river close both to the harbour and the bridge.

It comprises notably:

- the power station
- the water purification plant
- the liquid oxygen plant (BEC)
- a fuel storage area
- custom offices, forwarding agent's offices

6.3. LOCATION OF THE SATELLITE TEAMS

The teams in charge of preparation and checkout of satellites will generally use the following rooms and installations during their stay in Guiana:

6.3.1. Satellite preparation building (Technical Centre)

This building is exclusively intended for satellite and payload preparation. It has been designed to allow simultaneous preparation of two satellites.

During the launch phase the satellite teams may if required conduct telemetry checkout of the satellite from this facility.

6.3.2. The launch Centre (ELE)

Once the satellite is mounted on the EUROPA vehicle it is commanded from the Launch Centre. A part of this Centre is reserved for the satellite team's racks and individual consoles.

The ground equipment associated with the satellite is connected to the satellite by the functional links described in paragraph 6.10.1.

.../...

6.3.3. The Forward Test Post (ELE)

This post which is located below the umbilical mast, houses the checkout and command equipment associated with the satellite.

It has to be evacuated during hazardous operations and, in particular, following final arming.

The functional links between the Launch Centre and the payload are disconnected at this level.

6.3.4. The Servicing Tower (ELE)

This mobile tower allows for vehicle erection. Assembly of the satellite on the upper part of the launcher is carried out from platform 8 of this tower.

During preparation, the servicing tower also encloses the fixed umbilical mast carrying the umbilicals.

6.3.5. The Control Centre (Technical Centre)

The Control Centre located within the Technical Centre is a four-floor building occupied as follows:

- ground floor : telecommand transmitter
- first floor : computer/predicter rooms
- second floor : safety room
- third floor : control room

Launches are directed from the Control Room by the Director of Operations (DDO). The principal launch officers - Head of Mission, Satellite Officer and Launcher Sponsor - are on duty in this room during the launch sequence.

.../...

6.4. GENERAL INFORMATION

6.4.1. Access to Guiana

6.4.1.1. Port of Cayenne

The port of Cayenne comprises two docks, one at Cayenne proper and the other located at Larivot. The latter handles mainly tankers but can be used for unloading freighters should the Cayenne facilities be occupied. There is only a limited amount of warehousing space available at the Larivot docks.

6.4.1.2. The Kourou landing stage

This landing stage will take vessels of up to 4 m draught and 1000 tonnes lading.

6.4.1.3. Cayenne - Rochambeau Airport

The runway is 3200 m long and is situated approximately 15 km from Cayenne. It is the only airport of international class in French Guiana. Air France long-distance flights from Guiana use this airport. There are a number of Air France flights each week from Paris via Pointe-à-Pitre and Fort de France.

Other companies (KLM, PANAM, etc..) operate services between Europe and Surinam, Guyana, and the West Indies.

6.4.1.4. The road from Cayenne to Kourou

The old RN 1 road crosses the MAHURY river by ferry (15 minute crossing). This road is still in use and must be used by heavy vehicles. The distance from Cayenne to Kourou by this route is approximately 75 km.

A new road, known as the "Galion" road, enables Kourou to be reached without using the ferry. In this case the distance from Cayenne to Kourou is some 100 km. It can only be used by light vehicles.

The roads combine for the final stretch before Kourou, which includes in particular the 400 m long Kourou bridge.

6.4.2. Transport - handling - storage of equipment

Transport, handling and storage operations with ELDO equipment are to be carried out in accordance with the existing procedures.

Customers may if they wish have these operations in respect of their equipment carried out by ELDO. This paragraph sets out the arrangements which will be followed unless the customer decides otherwise.

.../...

All facilities requested from ELDO will be set out by the customer in the Launch Request.

6.4.2.1. Transport of equipment in Guiana

Transport of ELDO equipment to Guiana and back is governed by Technical Regulation 18.

All operations are channelled through the Secretariat to enable equipment to be grouped. For the outward journey, operations are directed by the Trials Directorate and for the return journey by the ELDO/Guiana Directorate.

The satellite equipment can be shipped between Europe and Guiana in the same way. It is planned to draw up standard transport procedures in order to provide the transport agents with suitable instructions.

It should be noted that for the transport of fragile and very costly equipment the presence of an accompanying person may be requested.

The information and documentation required by ELDO for the transport of equipment are stated in Technical Regulation 18.

Transport by sea from France takes approximately one month. Air transport may be by regular flight or charter.

The costs of transporting satellite equipment will be borne by the satellite user.

6.4.2.2. Handling of equipment in Guiana

The handling of equipment arriving at or leaving Guiana is carried out by various specialised services (dockers at Cayenne, Air France at Rochambeau, CSG at the port of Kourou).

The handling of satellite equipment at the various space centre locations (unloading or loading of boxes or containers on lorries) can be undertaken by ELDO. Such operations will then be carried out in accordance with the standard transport procedures.

It is however desirable that representatives of the satellite teams be present at these operations when the equipment is fragile or costly.

The satellite teams will have at their disposal during their stay in Guiana the handling equipment available in the facilities they occupy (mobile gantry). They may also make use of various specialised items of equipment available in Guiana (crane, fork lift truck) for special operations. Special facilities required should be stated in the Launch Request.

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In addition the following mobile handling equipment is permanently available on the ELE assembly zone:

- 1 flat trailer 2 x 1 m for sundry transport within the buildings (maximum load 2 tonnes),
- 1 lift-truck with thermal engine, fireproof, load 5 tonnes, can be fitted as towing vehicle and with a jib crane,
- 1 tractor with thermal engine and rear platform, of the UNIMOG type, approximately 50 HP,
- 1 truck, load 1 tonne, electric, can be equipped as a towing vehicle and fitted with a jib,
- 2 pallet transporters.

6.4.2.3. Transport of equipment on the Centre

Transport of satellite equipment from the harbour or airport to the Space Centre can be undertaken by ELDO. The presence of satellite team representatives to accompany the equipment may be requested.

During launch period, transport of satellite equipment between various locations and, in particular, between the payload preparation building and ELE can be undertaken by ELDO.

Any such transport requirements should be stated in the Launch Request.

6.4.2.4. Storage of equipment

It may be necessary for equipment to be stored at the unloading or loading point in appropriate facilities for the purpose of customs clearance.

Once customs formalities have been completed the satellite equipment will be brought directly to the scheduled locations (preparation building, ELE) with the exception of hazardous material. The satellite teams should ensure that the final destination is marked on the packaging.

Two special storage areas exist at CSG, one for propellants and the other for pyrotechnical equiment. Storage of empty containers during the launch period is a problem specific to each mission and will be dealt with during the preparation of the launch.

For the return journey to Europe all equipment will be collected and stored in the Kourou harbour warehouse (a non-airconditioned surface of 1250 sq.m).

6.4.2.5. Packaging of equipment

It is the responsability of the satellite teams to provide the packaging and containers which are to be reused for the return journey.

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The satellite teams will also be responsible for taking out or repacking their equipment in the appropriate containers.

They may avail themselves of ELDO's assistance for any refurbishing of containers that may prove necessary.

6.4.2.6. Customs clearance

All equipment entering Guiana is subject to the "octroi de mer" (dock dues).

Goods are examined by the customs at Rochambeau (Cayenne) at Kourou harbour, or at the CSG.

Experience to date has been that this examination has been made under technically acceptable conditions and within a short time where all the required documents had been supplied and correctly completed.

6.4.2.7. Insurance of equipment

ELDO does not insure its equipment.

6.4.3. Transport and accomodation of personnel

6.4.3.1. Transportation of ELDO staff or of personnel working for ELDO to Guiana is governed by ELDO Technical Regulation No. 8

The procedure laid down provides for seat reservations, reception in Cayenne-Rochambeau and hotel reservations at Kourou.

An identical service can be provided by ELDO for the satellite users. The travel expenses of satellite personnel are borne by the users.

6.4.3.2. The Launch Request should give a list of the satellite personnel who will participate in the firing.

6.4.3.3. During periods of peak activity, accomodation in air-conditioned hotels will be available in Kourou for approximately 220 persons.

For EUROPA firings, satellite teams comprising 50 persons are normally scheduled.

ELDO will examine with the satellite authorities any appropriate solution should a larger number of satellite personnel be requested.

6.4.3.4. The hotels in Kourou comprise restaurants. In addition, an ELDO cafeteria which provides meals is located on the ELE. There is also a large number of small non air-conditioned restaurants in Kourou.

6.4.3.5. ELDO can make a number of light vehicles or minibuses available for transportation of the satellite teams on the launch centre. The corresponding requirements should be stated in the Launch Request.
A Hertz car rentant service operates in Cayenne.

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6.4.4. Workshops and sundry facilities

6.4.4.1 Workshops

The Space Centre's workshop section comprises 1500 m^2 of shops housing the general engineering group and the motor vehicle group.

The general engineering group comprises notably:

- one ALCERA universal miller
- one CELTIC 17 lathe
- one COPEXHA D4 sharpening machine
- two column drillers (20 mm and 30 mm)
- one reciprocating saw with 200 mm thrust
- one hand roller (maximum thickness 6 mm by 2 m)
- one hand fotding machine 1200 by 3 mm
- one hydraulic motor press (main actuator 30 tonnes, auxiliary manual actuator 6 tonnes)
- a forge
- welding booths.

The motor vehicle mechanical group carries out all repair work on the Centre's vehicles.

An office machinery group maintains and repairs the typewriters, calculating machines, ...

In addition, the EUROPA Assembly Building (ELE) is flanked on each side along its full length by ancillary buildings containing workshops, laboratories, and offices for integrating and checking-out the rocket's propulsive stages (except the 4th stage motor) prior to its erection. The dimensions of the Assembly Building are such that two EUROPA launch vehicles can be accomodated at one time. It is equipped with two gantry cranes rated at 100 KN with a clearance of 8 m below the hook. Medium and low voltage electric power, hydraulic oil, gaseous nitrogen, and compressed air at 10 bars (produced by two 850 m^3 compressors) is available. There is also a mechanical workshop equipped with:

- one precision drilling machine, up to 13 mm
- one vertical drilling machine, up to 30 mm
- one HDP 200 LEP 600 lathe
- one reciprocating saw, blade length approximately 500 mm
- one base-mounted grinding machine.

6.4.4.2 Electric power

The power section of CSG is in charge of servicing and repairs of electrical installations. It also has mobile emergency generating units.

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6.4.4.3. Photographic laboratory

The photographic laboratory group looks after the development of black and white and colour films, copies, display and assessment. It has facilities for still photography and cisefilm.

6.4.4.4. Measuring equipment section - Laboratory

This section of CSG is responsible for preventive and corrective maintenance and calibration of the measuring equipment used by CSG. A catalogue of all measuring equipment (ELDO and CSG) managed by this section is available.

6.4.4.5. Printing and reproduction facilities

The following reproduction and printing facilities are available at the Space Centre:

- a micro-photography unit
- Gestetner, Geha and other duplicators
- OCE 1100 and 3 M photocopying equipment
- extra-wide (1.10 m) blue-printing machines
- a document plastifying machine.

6.4.4.6. Topographical facilities

The CSG topographical section can carry out the following work:

- 1st - 2nd order geodesy and complementary triangulation
- determination of direct and inverse azimuths, aerial orientation
- micro-geodesy and micro-triangulation
- surveys at all scales and high accuracy contourning
- various operations concerning position astronomy.

6.4.4.7. Motor storage area

This storage area comprises three non air-conditioned stores for motors, measuring 10 m by 7 m. Each store is equipped with a manual 5 tonne gantry crane. It also comprises three non air-conditioned stores for pyrotechnical devices, equipped with a 500 kg monorail pully. Two of these stores measure 3 m by 3 m and the third on 4 m by 3 m.

6.4.4.8. Liquid propellant storage area

In addition to the storage buildings and associated equipment, the area comprises the safety and neutralisation installations and an analysis laboratory.

UDMH, N2O4, hydrazine and non-toxic propellants may be stored on this area. Storage is in drums. Propellants are transported in tank trailers equipped with refrigeration facilities for thermal control of the propellants before loading in the vehicle tank.

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6.4.4.9. Oxygen and nitrogen liquefation plant

This plant situated in the industrial zone, is a production unit designed for a daily output of:

- 6.3 tonnes of liquid oxygen
- 2.8 tonnes of liquid nitrogen

The plant also possesses storage tanks and three multi-purpose semi-trailers for transportation.

6.4.4.10. Meteorological facilities

The CSG meteorological section has available:

- a ground observation station with all the usual equipment
- a wind measuring unit comprising notably a 100 m mast for sounding rockets
- an APT unit for receiving photos from ESSA, ITOS and NIMBUS satellites.

This section is assisted by the Cayenne station.

6.4.4.11. Medical centre

The medical centre is fully equipped for general medical practice. It possesses notably, an electrocardiogram, a binocular microscope and radiography equipment with the possibility of screening. A surgical section is in service. All general and emergency surgical operations can be carried out. The medical centre also has its own emergency pharmacy.

6.4.4.12. Telemetry station

The following telemetry receiving stations are in service at the Space Centre:

1. The 216-260 MHz receiving station on the Montagne des Pères.

This station principally comprises:

- an ARTEMIS I (26 db) auto-tracking aerial which can also be manually commanded or radar slaved
- a TACO (12db) aerial with adjustable elevation and bearing
- three receiving racks each equipped with tree receivers one of which is a standby
- one mixed PCM - predetection rack
- two checkout racks
- two 14 track magnetic recording units

2. The 136-138 MHz receiving station on the Montagne des Pères.

This station is principally equipped with:

- a 22 db gain aerial with controlled speed (or position) and adjustable elevation or bearing
- two receiving racks each comprising 3 receivers, one of which is standby

.../...

- one checkout rack
- one predetection and PCM rack
- two 14 track magnetic recording units

3. The visual checking centre (CVI)

This centre is located in the telemetry building on the Montagne des Pères and comprises two rooms. The CVI is able to receive multiplex signals from the receiving units and to demultiplex them in real time. CVI houses, in particular, the following equipment:

- a 14 track magnetic reader
- a discrimination rack
- a control rack
- a checkout rack.

4. The Cayenne telemetry receiving station (216-260 MHz)

The major installations of this station are the following:

- one ARTEMIS II (18 db) aerial with autotracking which can also operate in manual mode
- two receiving racks each comprising three receivers
- two magnetic recording units
- one checkout rack
- one distribution frame

5. The Fortaleza (Brazil) receiving station

This station some 2000 km from the Space Centre acts as the downrange station for equatorial launches. Its coordinates are:

- latitude : 3° 52' 45" South
- longitude: 38° 25' 40" West
- height : 18 m

It has a BLI link to Kourou, via Cayenne and a normal link to the Brétigny operations centre. This station enables telemetry transmission to be received in the two frequency bands, 136-138 MHz and 216-260 MHz.

The main items of equipment of this station are:

- an Aoriste 136-138 MHz aerial: 22 db
- a Sud Aviation 216-260 MHz aerial: 18 db
- a collimating aerial
- a time-signal receiving aerial
- 7 receivers including one standby
- two 14 track magnetic recording units
- display equipment
- checking and maintenance equipment.

6. The IRIS receiving station (Kourou) - (136-138 MHz)

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6.4.5. Communications facilities between CSG and the outside

6.4.5.1. Telephone

CSG is currently linked to Kourou by 12 lines and to Cayenne by 8 lines giving access to the international network during working hours (from 7 a.m. to 6 p.m.). During launch period, however, access to the international telephone network may be obtained outside normal hours by special request.

6.4.5.2. Telex

The ELDO/Guiana Directorate is linked to the Secretariat in Neuilly by a telex line.

CSG for its part is linked:

- by one line to the international telex network
- by one specialised telex line to the CNES Centre in Brétigny from 6 a.m. to 7 p.m. (local time) with a 24 hour service during launch periods.

The DIANE-IRIS station is also linked to CNES Brétigny by an additional specialised telex line (24 hour service).

6.4.5.3. Telegraphy

Access to the commercial telegraphy network through Kourou post office.

6.4.5.4. Radio

Telephone and telegraph links between CSG and Fortaleza (Brazil) by BLI radio (7 kw transmitter).

6.4.6. Mail

There are regular postal services to Guiana. Mail between Guiana and France takes approximately three days. ELDO's Guiana address is as follows:

- ELDO/Guiana
  Post Box No. 115
  973 - Kourou
  (Guiana)

6.4.7. Climate

Guiana's climate is of the equatorial type; the temperature remains practically constant throughout the year and rainfall is abundant.

There are two dry seasons: the short summer in March with North-east trade winds, and the long summer from August to December with easterly trade winds.

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The average temperature varies between 25°C and 27°C. The absolute extremes are 19°C and 35°C. Daily variations in temperature are slight. The relative humidity is very high, with the daily average varying between 80 and 90 %. The average yearly precipitation is almost 4 m.

Guiana is situated outside the cyclonic zone. Wind speeds are not excessive. For 34 % of the year the wind speed at ground level is 1 m/sec. The predominant winds are North-easterly.

6.4.8. Organisation and responsibilities

The general organisation of a project and particularly of launch operations is described in Chapter 9 of this document.

The purpose of the present chapter is to briefly survey the organisation and permanent responsibilities of CSG and of the ELDO/Guiana Directorate.

6.4.8.1. General organisation of CSG

The Guiana Space Centre comprises:

- a Director
- a Deputy Director
- an Assistant to the Director responsible for coordination and general affairs
- an Operations Division
- a Measurements Division
- a Development and Performance Division
- a Logistic Division
- an Administrative and Financial Division

and three services under the Director of the Centre:

- a public relations department
- a safety department
- a medical centre

NB: The Director of Operations (DDO) is an engineer of the Operations Division.

6.4.8.2. Organisation of the ELDO/Guiana Directorate

The detailed organisation of the Directorate may be summarised as follows:

- a Director
- a Deputy Director / Technical
- a Technical Services Division
- an Operations Division
- an Administrative Division
- a Quality Control Section.

The head of the Operations Division acts during launch periods as Operations Officer. He is responsible to the Launcher Sponsor (appointed by the ELDO Secretariat)

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for directing vehicle preparation at ELE. He coordinates on ELE, the operations concerning preparation and launching of the vehicle and its payload. For this purpose the satellite team is placed under his authority for all operations conducted on the ELE.

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6.5. DETAILED DESCRIPTION OF THE SATELLITE PREPARATION BUILDING

6.5.1. General description

The Satellite Preparation Building is located at the CSG Technical Centre.

A general description of the facilities is given in Figure 6.5.A. The Building is managed and maintained by the CSG Logistic Division. A technical officer is permanently responsible for its correct operation.

This Building may be used:

1. during the preparation phase, for commissioning and checking-out the satellite
2. during satellite checkout when mounted on the vehicle
3. during the countdown and launch phase

A covered area outside the Building can accomodate two checkout trailers.

6.5.2. Description of the premises

6.5.2.1. Satellite preparation building (see Figure 6.5.A)

The satellite preparation building is divided into two equal parts divided by the clean room. These two parts, halls 1 and 2, share the same gantry crane.

The floor is of dust-treated cement. Headroom clearance inside the building is 7 m.

Hall No. 2 currently houses the D2 balancing rig which can however be moved if necessary.

6.5.2.2. Clean room (see Figure 6.5.A)

A clean room has been built in the centre of the building to permit satellite preparation in a dust-free environment.

The clean room communicates with the main building through an airlock.

The main dimensions of the clean room are as follows:

- clean room: 8mx 6 m, headroom 4 m;
- airlock ::4m x 6 m, headroom 4 m;
- airlock entrance: 2 double doors (overall width 3m, height 4m);
- clean room entrance: 1 double door (overall width 3 m, height 4 m) and one staff door (width 80 cm, height 2,10 m)

The clean room has two cable passages, one into each of the two halls. These passages are placed 30 cm above floor level. A description of these cable passages is given in Figure 6.5.C.

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The plates for covering these apertures whilst allowing for passage of the cables, are to be supplied by the users.

The characteristics of the clean room under slight overpressure are as follows:

- air-conditioning: $25^\circ \pm 3^\circ C$
- humidity: 45 % ± 5 %
- freedom from dust: 99.97 % of particles $> 0.3\ \mu$
- efficiency: 100 % of particles $\geqslant 1\ \mu$

The procedure for using the clean room laid down by CSG must be complied with by the users. In particular it is a requirement that special "clean room" clothing be worn inside the facility.

This clothing is to be supplied by the users.

Users may use a suction unit (in the airlock) and compressed air bottles (outside the airlock) for cleaning the exterior of the packaging and the containers which are to enter the clean room.

The clean room is not equipped with any kind of lifting device. Such equipment should be planned for and provided by the satellite teams.

6.5.2.3. Display room

This room, which is wholly sealed off, will contain the satellite checkout racks and consoles. A cable duct enables the display room to be linked to the trailer shelter.

The dimensions of this room are: 11.8 m x 4.8 m.

6.5.2.4. Paint shop

This laboratory can be used by the satellite teams to touch up paintwork on the satellite structures or modules.

The laboratory is divided into two parts: the workshop and the laboratory.

The workshop is wholly sealed off. It is equipped with a painting booth with an external extraction hood, a tub and a wall-mounted drying unit.

6.5.2.5. The laboratories (see figure 6.5.B)

The laboratories are located along the length of the building. Their arrangement is shown in figure 6.5.B. They are separated from each other and from the building by means of fixed glass partitions 2 m high.

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6.5.2.6. Stores

The satellite preparation building has two storerooms for the satellite team's equipment (containers, tooling ...).

The surface area of these storerooms is 45 m^2 and 95 m^2.

6.5.2.7. Offices, Conference rooms, Rest rooms

Four identically sized offices (4 m by 3.5 m) are installed on the first floor of the building together with two conference rooms (6.5 m by 4.5 m) and two rest rooms (6.2 m by 5.3 m).

6.5.2.8. Trailer shelter

The main entrance to the building is equipped with an awning, 16 m long and 14 m wide enabling two satellite checkout trailers to be sheltered.

A cable duct links this area to halls 1 and 2 and to the display room.

.5.3. Air conditioning

The air conditioning maintains the rooms at an average temperature of 25° ± 3°C and a humidity level of 60 % ± 10 %, with the exception of the clean room (45 % ± 5 %).

6.5.4. Handling facilities

The building is equipped with a gantry crane which can travel over the whole surface of both parts. It has the following characteristics: capacity of 3 tonnes, clearance below hook of 7 m.

A small fenwick-type electric lift-truck is permanently stationed in the satellite building. It is also possible, as mentioned in paragraph 6.4.2.2., to request additional mobile facilities (lift-truck, hoist ...). These are not intended for satellite handling.

6.5.5. Balancing facilities

A balancing rig is to be installed in the test building to meet the requirments of the D2A satellite. The characteristics and operations conditions of this rig will be communicated subsequently.

6.5.6. Communications

6.5.6.1 Landlines

Specialised landlines link the satellite building to the telecommunications Building and thus to the major CSG and BEC facilities.

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These links enable in particular reception of video and AGC information from the telemetry stations on the Montagne des pères and from IRIS (see Figure 6.5.E).

6.5.6.2. Radio-relay

The satellite building has neither a reception nor a transmission aerial. Users requiring this type of link will have to provide the aerials. Choice of location for the aerial will then be defined as a function of its characteristics and mission.

6.5.7. Control

6.5.7.1. Telephone

All laboratories, offices and rooms in the building are equipped with telephones.

6.5.7.2. Intercom

Intercom stations are installed where requested by the users. Intercom plugs are already provided in the main areas of the building (see chapter 6.10.2).

6.5.7.3. Countdown display

The display room is equipped with a transcoder which feeds one or more countdown or time display units. These drawers are fitted following the requirements of the users' programme.

6.5.7.4. Time distribution

The various types of time generated by the CSG master clock are available. A transcoder rack is installed in the display room.

6.5.7.5. Television

No television system is currently planned for this building.

6.5.8. Electrical energy and earthing system

The building is equipped with two distribution networks.

6.5.8.1. The lighting network

This provides the lighting and supplies the "domestic" sockets. Lighting is of the suppressed fluorescent type. Each room is equipped with at least two "domestic" electric sockets.

.../...

6.5.8.2. The equipment network

This feeds:

- on the outside, under the trailer shelter, two sealed double sockets units (220 V single-phase plus earth, 20 amps) and two sealed, screened power sockets (380 V three-phase plus neutral plus earth, 15 kilowatt);
- inside the building, socket boxes (220 V single-phase plus earth) and two power sockets (380 V three-phase plus neutral plus earth).

The socket fitted on the panels are standard Maréchal type

220 V / 380 V plus earth
220 V, 16 amp sockets type 2.415
380 V, 32 amp sockets type 2.417

Voltage and frequence stability of the CSG electrical power network is as follows:

- three-phase current (380 V three-phase plus neutral plus earth)
  voltage 380 V ± 10 %, frequency 50 HZ ± 2 %;
- single-phase current (220 V single-phase plus neutral plus earth)
  voltage 220 V ± 10 %, frequency 50 HZ ± 2 %.

6.5.8.3. Earthing network

The building has two earthing networks:

- a normal network for electrical equipment and motors. This network can be connected to that of the Technical Centre,
- a measurements network for the electronic equipment.

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6.5.9. Fluids

The following fluids are normally available in this building:

- a compressed air network enabling safety tooling to be used (STAUBLI half-inch automatic connectors),
- bottles (in principle nitrogen U) to operate the spray guns in the paint shop.

6.5.10. Conditions for using high pressure device in the building

CSG will make known these conditions shortly. Pending this refer to paragraph 8.5.

6.5.11. Furniture

All rooms in the Satellite Preparation Building are provided with furniture (benches, tables, desks, chairs ....).

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6.6. DETAILED DESCRIPTION OF THE SATELLITE SECTION OF THE LAUNCH CENTRE

6.6.1. General description

The Launch Centre is located on the ELE approximately 200 m from the Servicing Tower. It is constructed as a blockhous capable of withstanding an overpressure of 2 bars and the impacting of stage fragments. It is gas-proof and air-conditioned.

A part of this building is set aside for the satellite teams. The satellite teams will normally only use this room during operations with the satellite on the servicing tower and only up to light-up. The Launch Centre also houses the satellite racks and consoles for:

- operating hazardous circuits or systems,
- checks or actions via landline,
- possibly telecommand action and their checks,
- possibly telemetry checks,

All these racks are housed in the checkout equipment room.

The satellite operating officer is present at the payload console in the Launch Control Room. Together with the satellite expert at the Centrol Centre, he coordinates processing of data.

6.6.2. Description of the premises

The Launch Centre is a circular building with two levels: At ground level are:

- the Launch Control Room in the central part,
- the checkout equipment room,
- the equipment maintenance laboratory,
- the "withdrawn staff" and visitors room,
- the conference room,
- the records examination room,
- the safety operations room.

The basement houses equipment not requiring continuous monitoring in the following rooms:

- the checkout and communications cabling terminal room,
- the four stage sponsor offices,
- the room reserved for work on the batteries,
- the electricity and air-conditioning room.

The satellite operating officer is provided with a console in the Launch Control Room. The caracteristics of this console are:

two 8 U standard 19 inch units (figure 6.6.B).

.../...

This console is fitted to accept the master intercom post (see chapter 6.10.2 - ELDO supplies) and the display and stop-actions drawer (see chapter 6.10.2).

A second part of the Launch Centre is reserved for 14 standard 19 inch 35 U racks.

The location of this console and the space reserved for fitting the racks is shown in figure 6.6.C.

The links between the various racks can be effected below the floor through ducts which are provided. These links are the responsibility of the satellite teams.

6.6.3. Air conditioning

The temperature, humidity and filtering of the air in the Launch Centre are the same as for the servicing tower (see para. 6.8.3).

6.6.4. Handling facilities

A pulley at the entrance to the Launch Centre enables racks and heavy equipment to be lowered to the basement.

6.6.5. Communications

6.6.5.1. Land lines

The functional links foreseen between satellite and its checkout equipment are described in chapter 6.10.1.

6.6.5.2. Radio relay links

Telemetry aerials are located on the Launch Centre roof. The aerials are fixed. One array is oriented towards the servicing tower, a second array is oriented towards the assembly area. Each array comprises a 215-250 MHz aerial and a 136 MHz aerial.

A distribution panel in the Launch Centre enables the links with these aerials to be made.

6.6.6. Control

6.6.6.1. Telephone

All locations occupied by the satellite teams are equipped with telephones.

.../...

6.6.6.2. Intercom

See chapter 6.10.2.

6.6.6.3. Countdown display

See chapter 6.11.

6.6.6.4. Reporting and stop-action network

See chapter 6.12.

6.6.6.5. Time distribution

See chapter 6.11.

6.6.6.6. Television

Television receivers are located all around the Launch Centre. They enable operations on the Servicing Tower to be followed.

6.6.7. Electrical power

Electrical panels are located all around the Launch Centre. Each panel comprises:

- two MARECHAL 20 amp/220 V single-phase type 2215 sockets
- two RUSSENBERGER 10 amp/220 V single-phase type K33 sockets
- eight starts 220 V protected by circuit-breakers for connecting.

.../...

6.7. DETAILED DESCRIPTION OF THE SATELLITE SECTION IN THE FORWARD TEST POST

6.7.1. General description

The Forward Test Post (PCA) is one of the technical rooms located below the Launch Platform and whose roofing serves as a causeway for the Servicing Tower. The purpose of this room is to house the terminal equipment of the ground checkout facilities for the erected stages and the payload.

It has been designed in such a way as to reduce the level of vibrations and noises inside, at the instant of launch, to values acceptable for the electronic equipment located there.

It is obvious that the presence of any personnel in this room during hazardous operations and in particular, after final arming, is prohibited.

6.7.2. Description of the room

The room contains six rows of racks. The space reserved for the satellite equipment is in the fifth row. There is room for ten racks.

The distribution frames are located on the ground floor, at the extremity of the racks.

6.7.3. Air conditioning

The temperature, humidity and air filtering are the same as for the Tower (see paragraph 6.8.3).

6.7.4. Handling facilities

The room is equipped with a fixed pulley enabling heavy equipment to be lowered to the basement.

6.7.5. Communications

6.7.5.1. Land line links

See paragraph 6.10.1.

6.7.5.2. Radio relay links

No radio relay link with the PCA is foreseen.

6.7.6. Control

6.7.6.1. Telephone

A telephone is fitted in the Forward Test Post.

6.7.6.2. Intercom

See chapter 6.10.2.

6.7.7. Electric power

The racks are electrically connected to the following sockets:

- two MARECHAL 20 amp/220 V single-phase type 2215 sockets
- two RUSSENBERGER 10 amp/220 V single-phase type K33 sockets
- eight starts 220 V protected by circuit-breakers for connecting.

.../...

6.8. DESCRIPTION OF THE TOWER FACILITIES USED BY THE SATELLITE TEAM

6.8.1. General

The servicing tower is mobile and air conditioned. In its forward position it envelops the launcher assembly and the umbilical mast. It is 45 m high and measures 15 m by 12 m at its base. It is a metal structure clad with plastic panels. It contains seven fixed platforms each with two folding sections, and a mobile platform. The tower levels refer to a zero level 40 cm below the launch platform base (see figure 6.8.A).

6.8.2. Description of the platform No. 8

Upper platform No. 8 is the only mobile platform. It can be moved between the 40 m and 45 m levels. It moves at a speed of 2.5 m/min. Maximum load per square metre is 500 kg/sq.m and the maximum total load 10 tonnes. A description of this platform is given in figures 6.8.B and 6.8. C.

6.8.3. Air conditioning, cleanliness

Temperature:

a) at an outside temperature of more than $25^{\circ}C$: $25^{\circ} \pm 2^{\circ}$
b) at an outside temperature below $25^{\circ}C$: outside temperature $\pm 2^{\circ}$

Humidity: 55 % ± 10 %

Filtering: particles of diametre greater than 5μ : 97 %

An air blower is provided under the nose fairing. Its characteristics are as follows:

Temperature (on entry into the 3rd stage): $10^{\circ}C < \pm < 15^{\circ}C$

Humidity: 1g/kg

Filtering: for particles of diameter greater than 15μ : 100 %

Output: 250 kg/h

6.8.4. Lifting facilities

The following are available:

- a 20 tonne mobile gantry with two speeds for both lifting and lateral displacement: 6 m/min and 0.6 m/min. Maximum clearance below the hook is at the 48 m level. Figure 6.8.B shows the area of platform 8 covered by the gantry hook,
- 2 monorails, each of 500 kg. They are mounted on the same rail. The area of platform 8 served by these two monorails is shown in figure 6.8.B. Hoisting speeds are 6 m/min and 0.6 m/min. Travelling speeds are 5 m/min and 1.25 m/min. The supporting rails is located at the 51.23 m level,

.../...

- the service lift

  There is a service lift to all platforms. The gate dimensions are: height: 2 m, width 1.95 m. The lift depth is 2.185 m. Maximum permitted load: 1000 kg. Maximum speed: 5 m/min.

6.8.5. Electric power available on platform No. 8

The following electric power supply network is available at platform No. 8 level.

- 380 volt three phase 32 amp, for MARECHAL 32/10/107 fireproof four-pole plugs,
- 380 volts and 220 volts via two boxes each equipped with the following sockets:
  a) a 20 amp four-pole MARECHAL socket
  b) 5 RUSSENBERGER ref. 33 K 220 volt 10 amp sockets.

These boxes are protected by a 20 amp four-pole circuit breaker.

6.8.6. Fluids available at platform No. 7

The following fluids are available at platform No.7:

- LP clean air (0-10 bars)
- service air (0-10 bars)
- service water

6.8.7. Umbilical mast

This is a metal framed pylon 30 m high, comprising 8 platforms at the following levels: 16 m, 22 m, 27 m, 31 m, 33.5 m, 35.8 m, 38.05 m, and 40.3 m. The surface of theses platforms is approximately 1.8 m by 1.8 m. Permissible loading on these platforms is 350 kg/m^2 with a maximum of 1 tonne.

Access to the platform is by ladder when the tower is withdrawn.

The satellite umbilical junction box is located at the level of the upper platform.

.../...

6.9. DESCRIPTION OF THE CONTROL CENTRE

6.9.1. Launching are directed from this room which contains eleven work posts (see figure 6.9.A). These posts are occupied as follows:

1. Satellite expert;
2. Launcher sponsor;
3. Head of mission;
4. Director of operations (CSG);
5. Assistant Director of operations (CSG);
6. Assistant / measurements (CSG);
7. Assistant / technical (CSG);
8. Plotting table officer (CSG);
9. CNES station network officer;
10. CSG Director
11. Officer / logistics (CSG);

12.)
13.)Officer / recovery (CSG);

14. Technical commentator (CSG).

6.9.2. This room contains the following equipment:

- three television screens
- two plotting tables for reconstituting the trajectory
- two display panels which show information on the progress of the launch preparation and sequence.

6.9.3. The Head of Mission is stationed in the Control Room close to the Director of Operations and may be assisted by a number of experts and advisers. Three consoles are provided for the experts. The Head of Mission is responsible for satisfactory completion of the mission in hand. He is kept informed of the progress of operations and any change in the launch order is subject to his decision.

He may communicate with DDO, the ELE Operations Officer and with any other person previously defined and named in the Launch Instruction. Should the countdown be stopped for an unforeseen reason he will have full access to facilities for communicating with any person he wishes.

6.9.4. The external facilities assistant to the DDO, who is stationed in an individual box, has a permanent link to the Operations Centre in Brétigny which coordinates the network of CNES tracking stations and as the case may be those of NASA.

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6.10. FUNCTIONAL EQUIPMENT MADE AVAILABLE TO THE SATELLITE TEAM

6.10.1. Satellite functional links

Cables are permanently laid between the Launch Centre, the Forward Test Post and the Umbilical Mast to provide the functional links between the various satellite operational and checkout equipments and the satellite itself.

A schematic of these links is given in figure 6.10A.

6.10.1.1. Characteristics of the 56 pair cables

The 56 pair cables are standard NTHG telephone cables constructed as follows:

- core of 9/10 conductor load red copper
- each conductor is isolated with polyvinyl chloride (PVC) with a radial thickness of 3/10
- pairs inter-assembled
- insulating tape
- aluminium tape acting as a screen with 5/10 tinned copper banding strip
- grey coloured polyvinyl chloride (PVC) sheat with rupture wire.

The electrical characteristics are as follows:

- resistance: 27.5 to 30 ohms/km
- insulation better than 500 m ohms/km
- voltage rating: 800 volts between conductors
  800 volts between conductor and screen
- working voltage: 72 volts
- capacity: 100 p.F/m between 2 conductors of a same pair

6.10.1.2. Characteristics of the 30 pair cables

These are also standard NTHG telephone cables constructed as follows:

- 9/10 red copper core
- polyvinyl chloride (PVC) insulation
- screened in pairs
- insulating tape
- grey polyvinyl chloride (PVC) sheat with rupture wire

The electrical characteristics are the same as for the 56 pair cables.

6.10.1.3. Characteristics of the connecting strips

The cables end at distribution frames. They are wired to connecting strips fixed directly on brackets. Each distribution frame comprises four rows of eight or nine connecting strips.

The characteristics of these connecting strips:

- manufacturer, POUYET
- high quality RBS type - ref. 634.051.00
  the capacity (3 x 20) is sufficient for 30 pairs.

.../...

They are made up as follows:

- an insulating base through which the wires pass
- a set of "single notch" pins
- two insulating plates crimped in a metal frame to hold the pins
- a label holder
- a lid (contingently).

Unwired connecting strips are available on the distribution frames for connecting up cables from the satellite racks and equipment.

Interconnexions are made between the various connecting strips.

6.10.1.4. The rack and console connecting cables

The satellite teams are required to supply the necessary cabling for linking their racks and the satellite operation officer console with the distribution frames.

6.10.1.5. Umbilical mast "payload" cable distribution head

A cable distribution head, also referred to as the payload umbilical junction box, is mounted on the umbilical mast to ensure the continuity and distribution of the cabling for the satellite circuits.

This cable distribution head is of the screened type and is pressurised at 10 millibars. It is integrated into the cable chute with pressurisation being effected by means of this chute.

Inside, a frame with two vertical U shaped brackets enable connecting strips of the 3 x 20 pairs type to be mounted.

6.10.2. CSG interphone networks

6.10.2.1. A detailed description of the interphone network is given in ELDO document "Telecommunication systems on the EUROPA launch site" DS 262.

6.10.2.2. The Director of Operations (DDO) at the Control Centre has a principal interphone network enabling him to contact key personnel, (the Head of Mission, the Launcher Sponsor and Satellite Officer at the Control Centre, the Operations Officer at ELE, the CSG Measurements Officers, the CSG Safety Officer ...).

6.10.2.3. The Operations Officer at ELE has a main command interphone network linking him with the key ELE personnel (Stage Sponsors, Satellite Operations Officer ...).

6.10.2.4. The Satellite Operations Officer at ELE has an intermediate interphone network linking him with the main payload officers and operators.

.../...

The maximum of subscribers for this type of network is 12. The total of subscribers for the ELE interphone network is limited to the capacity of the switchboard. Present planning for the network is that the number of subscribers on the satellite operating network will not exceed five. These may be inside or outside the EUROPA launch Centre.

The subscribers may either have independent extensions or form a group of extensions (a maximum of ten extensions).

Where the subscriber has a group of extensions, this group may communicate with each other independently of the command station. These extensions are equipped with a mutual calling system.

A main command station comprises two standard 19 inch mounting plates, each being one unit. The depth of the station is 315 mm, to which 100 mm must be added for connectors and cabling.

The Satellite Operation Officer is able to speak to any of his subscribers simply by pressing a button. He may also speak simultaneously to all or a number of his subscribers. In this case the selection is made at his request on a switchboard. If he wishes he may make a number of conferences calls simultaneously.

6.10.2.5. The subscribers are equipped with secondary interphones. These are of two types:

- instruments which can be integrated in a rack or console (PS 1). A PS 1 is a standard 19 inch mounting plate, height 1 unit, depth 315 mm to which 100 mm must be added for connectors and cabling;
- portable secondary instruments (PS 2). These take the form of a case (height 282 mm, width 124 mm, depth 300 mm) fitted with a carrying handle.

6.10.2.6. All command interphone or secondary instruments can be used with headphones. The portable secondary instruments (PS 2) are fitted with an incorporated loudspeaker which serves exclusively for monitoring. The integrated secondary instruments (PS 1) and the command stations are equipped with a jack enabling a monitoring loudspeaker to be connected.

.../...

6.10.2.7. The Satellite Operations Officer may, via his command station, call any other ELE subscriber and also certain extensions in the CSG and may receive calls from all of these.

6.10.2.8. In the Launch Request which the user has to draw up, the number and locations of extensions requested by the customer and also the type of each extension (PS 1 = fixed of PS 2 = portable) shall be stated.

6.10.2.9. A public address system is available for broadcasting instructions or general information to one or more areas of the ELE. A general or selective call is possible for all zones from each command station.

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6.11. TIME DISTRIBUTION

6.11.1. Time distribution on ELE is detailes in CNES document "Time Distribution on ELE" CNES/CST/EG/MM dated December 1967, and also in CNES design sheet 340A dated 29 May 1969.

6.11.2. CSG possesses a time distribution network for the purpose of:

- coordination of operations during countdown
- preprogrammed automatic sequence commanding
- time coding of recordings.

6.11.3. Time is distributed in two modes:

- coordinated time - universal time, time bases
- relative or countdown time whose zero sequence time coincides with scheduled launch time.

Only the seconds are synchronised between the two time distributions.

6.11.4. The coordinated and countdown time distribution network available on the EUROPA launch site (ELE) is completed by a local countdown generator which is able to:

- work autonomously to enable sequences to be rehearsed independently of the overall CSG countdown,
- time a vehicle and launch pad disarming sequence in the case of a countdown hold during the 1st stage engine light-up sequence.

6.11.5. Coordinated time

Generated by the CSG master clock set to the world time signals (e.g. WWV).

It is distributed on the CSG, either by land line or by radio relay, in three forms:

- IRIG B
- NASA 36 bit
- PADTC (pulse amplitude duration time code).

The IRIG and PADTC codes are available on ELE and can be used for time coding recordings.

Coordinated time can be displayed by means of time display units coupled with a standard transcoder. They are standard 19 inch drawers.

The IRIG and PADTC codes modulate in amplitude a 1000 HZ carrier, the code resolution being 1 millisecond.

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6.11.6. Countdown

The master clock generated countdown time from plus to minus 23 hours 59 minutes 59 seconds which is distributed throughout CSG and ELE.

This countdown time enables a launch to be made according to a fixed countdown. During the launch sequence the local generator on the EUROPA launch site is slaved to general countdown time by the master clock.

The countdown time provided by the local generator, working either in independent or slave mode, is distributed to the checkout equipment:

- in BCD 22 bit form in parallel for use by the computers (see 6.11.7),
- in decoded decimal form for controlling the countdown display units. These units take the form of drawers which can be fitted in standard 19" consoles or racks.

Its main characteristics are as follows:

- height: 2 possible heights depending on the model, 1/2 inch, 1 inch,
- width: 483 mm (19 inch),
- depth: 350 mm including connectors, connected by SOCAPEX plugs, series 45, 55 pin to BNA standard.

6.11.7. Distribution of countdown time to the computers

1. Each of the three lower stages of the EUROPA II vehicle is associated with checkout and firing command equipment including a computer.
2. The checkout and command functions are linked to the countdown. The countdown time is available in BCD form at the transcoder output of the time distribution equipment.
3. An adapter enables the countdown time taken from the single transcoder output to be distributed to the checkout equipment computers.
4. Document ELDO SR 23 (issue 2 dated 14 May 1969) gives the specification of this adapter.
5. Outputs
   The interface block has separate outputs for the first, second and third stage computers plus a fourth standby output (available to the user).

.../...

The following information is available at this output:

- countdown time in BCD (hours, minutes, seconds) and the countdown sign (plus and minus on two separate 22 bit outputs)
- the read-out command (frequency 1 HZ)
- the "hold bit" information
- the "countdown hold" information
- an OV output (common).

The read-out order information is obtained from the 1 HZ frequency signal with significant front wave located at 11.5 milliseconds in relation to the second round.

The parallel binary coded decimal data (1.2.4.8.) corresponds to time information expressed in hours, minutes, seconds, sign and the "countdown hold"bit" signal.

The levels are as follows:

- amplitude level "1": 12 volts ± 15 %
- amplitude level "0": 0 volts ± 0.7 volts
- source impedance : 1 K Ω
- load impedance : R = 5 K Ω
  C < 100 pF

Rise time: $\leq$ 5 μ seconds

The outputs are of the floating type. Connexion is made with a plug of the following type:
SOCAPEX 55 pin BCD connector.

Base: No. PT 02 A 22 55 ground
Plug: No. PT 08 A 22 55 POI-SR

Pin distribution identical to 3rd stage output.
The pin distribution is given in document SR 23 (Issue 2).

6.11.8. Programmers

Programmers connected to a transcoder are used to control the closing of a certain number of relay contacts at predetermined moments. Each programmer comprises two monostable relays, and 48 bistable relays with magnetic locking, which can be used by the checkout equipment.

Each relay comprises two insulated changeover contacts:

- triggering time : 10 milliseconds
- contacts: palladium silver
- breaking capacity: 5 amps, 28 volts DC or 127 volts AC
- connexion: over the distribution frames (POUYET connecting strips).

Each relay can be programmed to switch in one direction and/or another at any moment between minus 19 minutes 59.9 seconds and plus 19 minutes 59.9 seconds with a resolution of 0.1 second and an accuracy of 20 millseconds.

.../...

Only the commands given during the automatic sequence (H - 5 minutes) are programmed at present.

There is no number of relays specifically allocated to the payload. The user will state his requirements which will be taken into consideration by ELDO.

.../...

6.12. STOP ACTION FACILITIES AND READY NETWORK

6.12.1. The satellite team may intervene, in the same way as the stage teams, to hold the countdown.

6.12.2. Preparation for launch of the vehicle and the satellite is completed when the vehicle, the satellite and the associated ground equipment satisfy the required conditions of starting the automatic sequence. Each element and each system is then in a clearly defined and characteristic "READY" state.

6.12.3. A reporting network presents a continuous picture of the changing system stated at the level of the stage sponsors and Satellite Operating Officer, and at the level of the Operations Officer whose console is equipped with a row of lights which signal the "READY" state.

6.12.4. The "READY" state of a given system is held as long as the conditions defining this state are also maintained.

6.12.5. The automatic sequence having been initiated, the countdown can be stopped.

A stop-action can be commanded either by automatic control devices or by push buttons at the disposal of the operators and of the Satellite Operating Officer.

6.12.6. A stop action during the automatic launch sequence in all cases causes the master clock countdown to stop, which in turn stops the local generator if it takes place prior to first stage engine light-up. In the opposite case the local countdown generator jumps to positive time and initiates a disarming sequence.

6.12.7. A countdown stop order generated automatically or manually should cause the corresponding "READY" signal to disappear immediately. Manual depressing of the appropriate "READY" push button is necessary to subsequently return to the "READY" state and enable the countdown to continue.

6.12.8. The "STOP ACTION" and "READY" signal circuits for the satellite shall be provided by the satellite team.

6.12.9. Space is provided in the Satellite Operating Officer's console for the corresponding display and command drawer.

6.12.10. The design of these circuits and of the drawer referred to in paragraph 6.12.8. will comply with the standards and drawings described in ELDO's specifications SR 16 (Ref. E 44/54/BP/MV, issue V).

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- Specifications for mating the countdown equipment BCD output to the automatic checkout computer inputs: ELDO doc. SR 23, Issue 2, dated 14th May 1969
- Installations specifications. Acceptance requirements. Earthing of equipment and measurement circuits.

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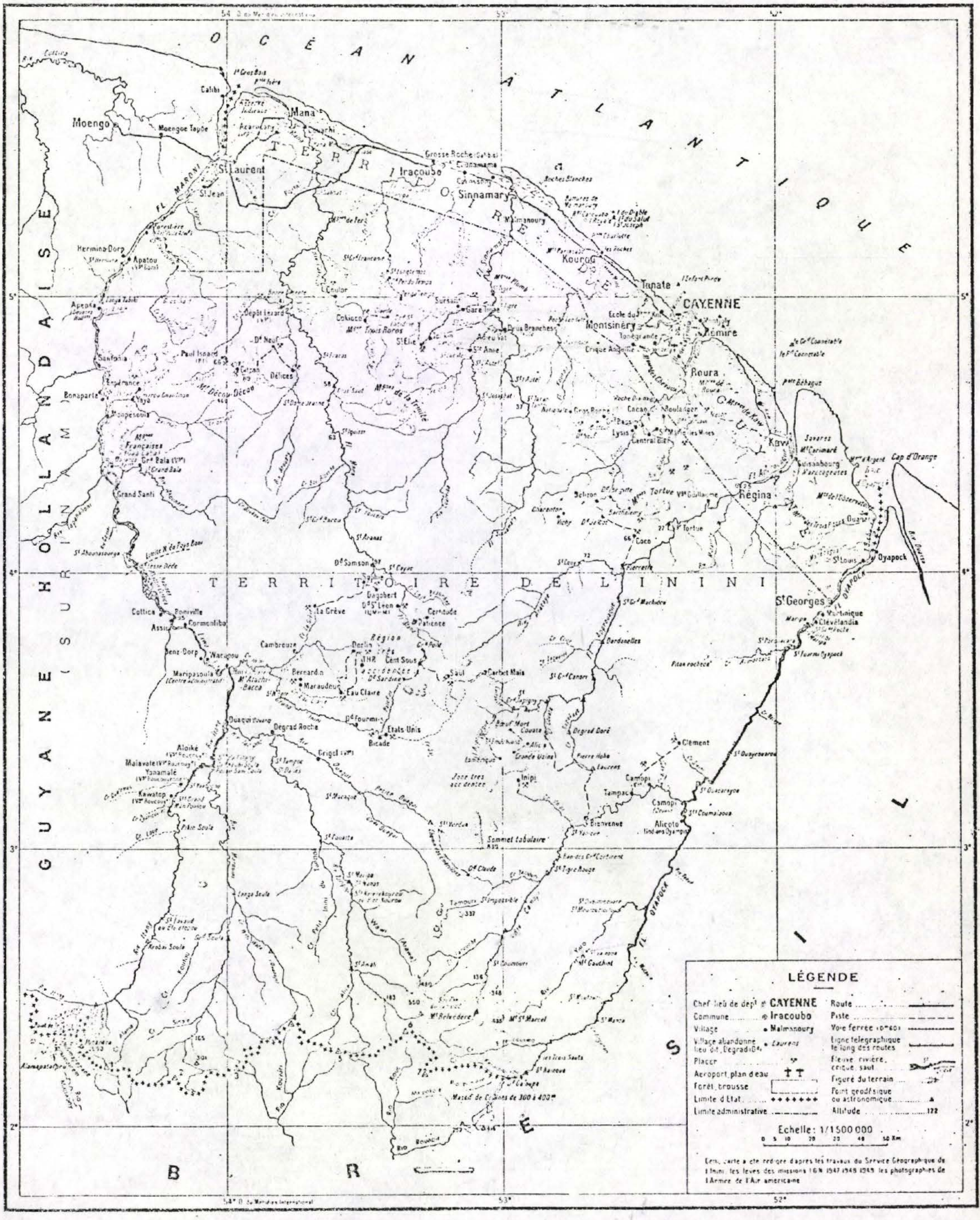
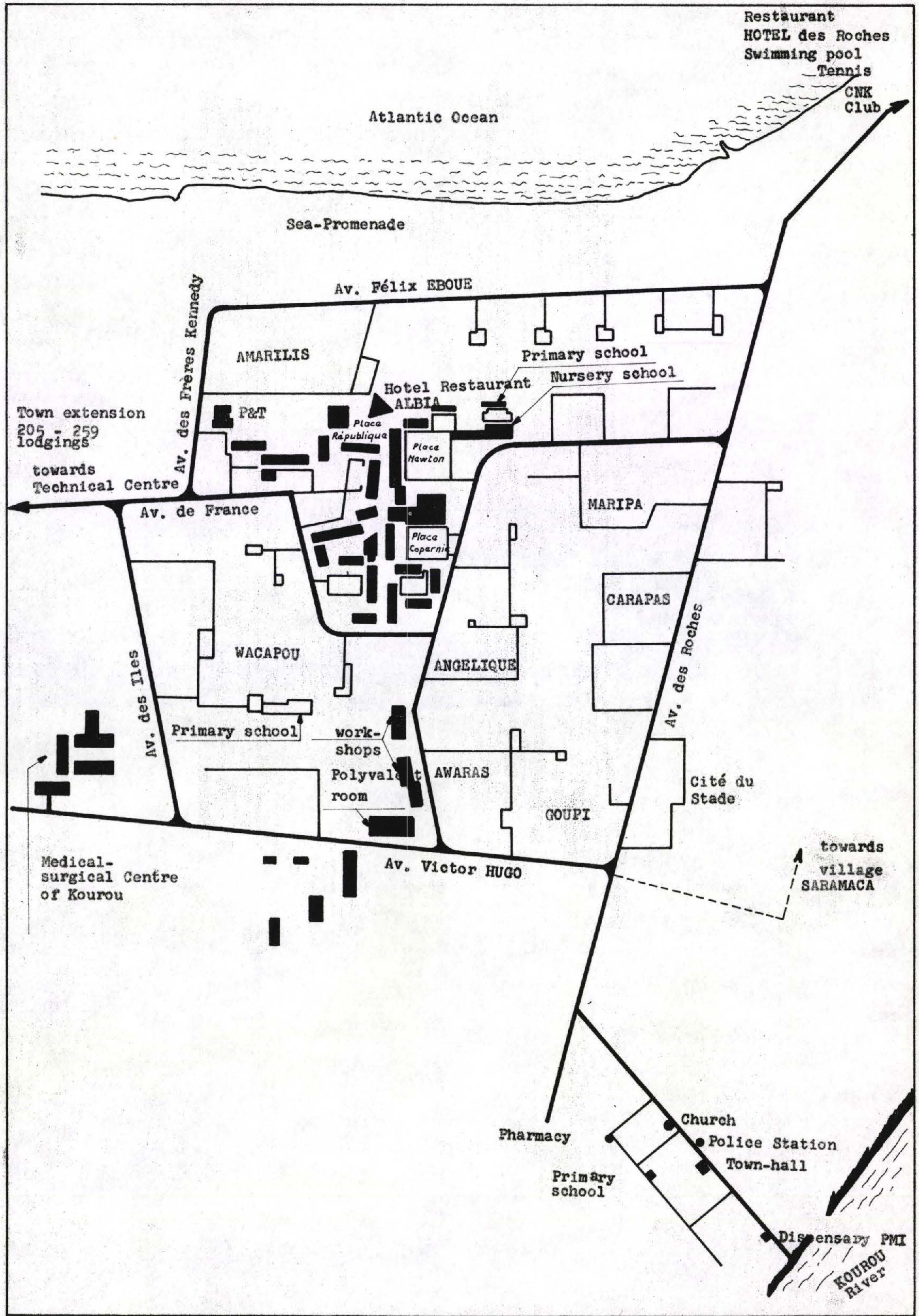
CARTE DE LA GUYANE FRANÇAISE





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MAP OF THE TOWN OF KOUROU

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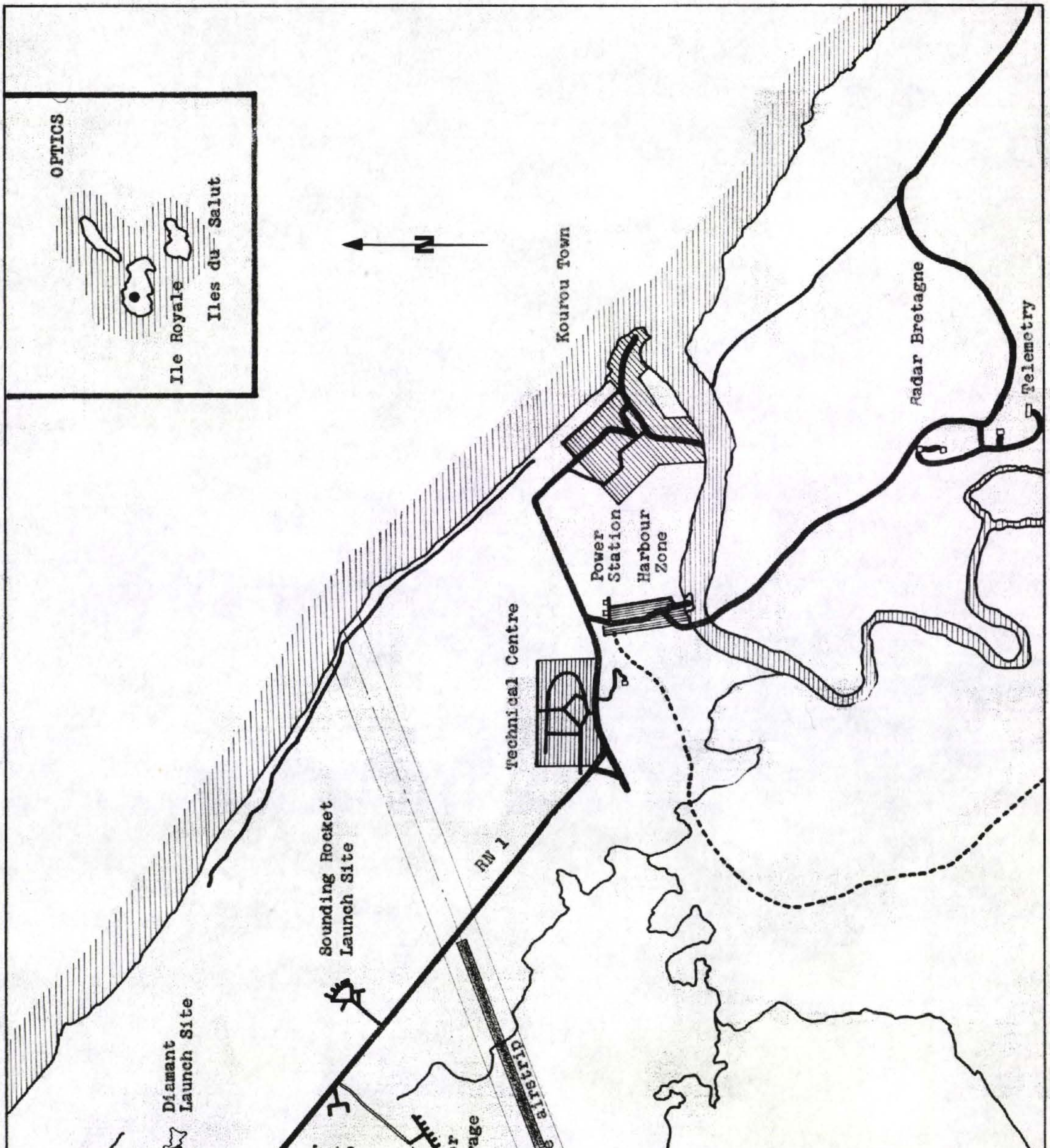
6.1.B



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LOCATION OF CSG AND BEC FACILITIES

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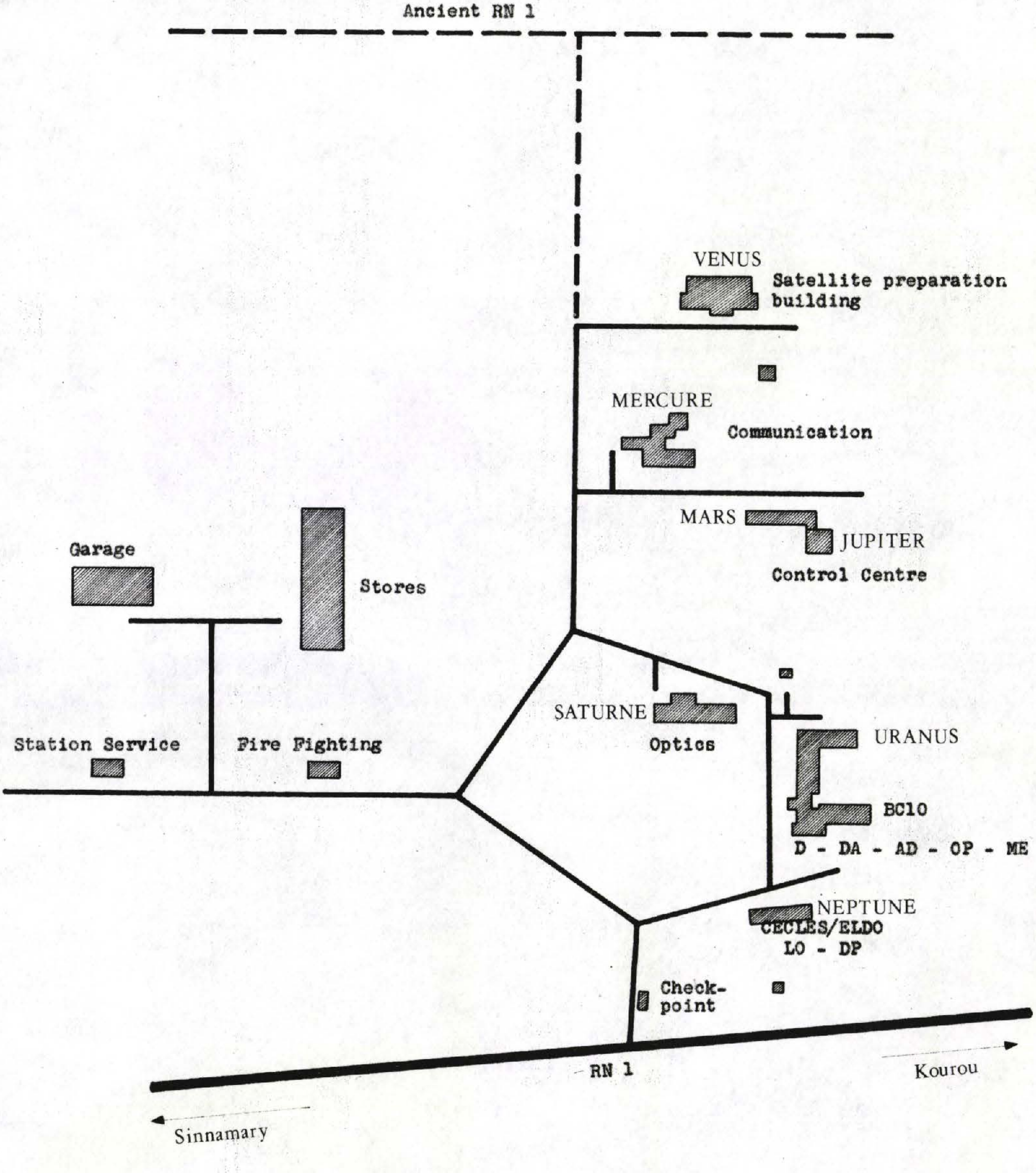

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CSG TECHNICAL CENTRE

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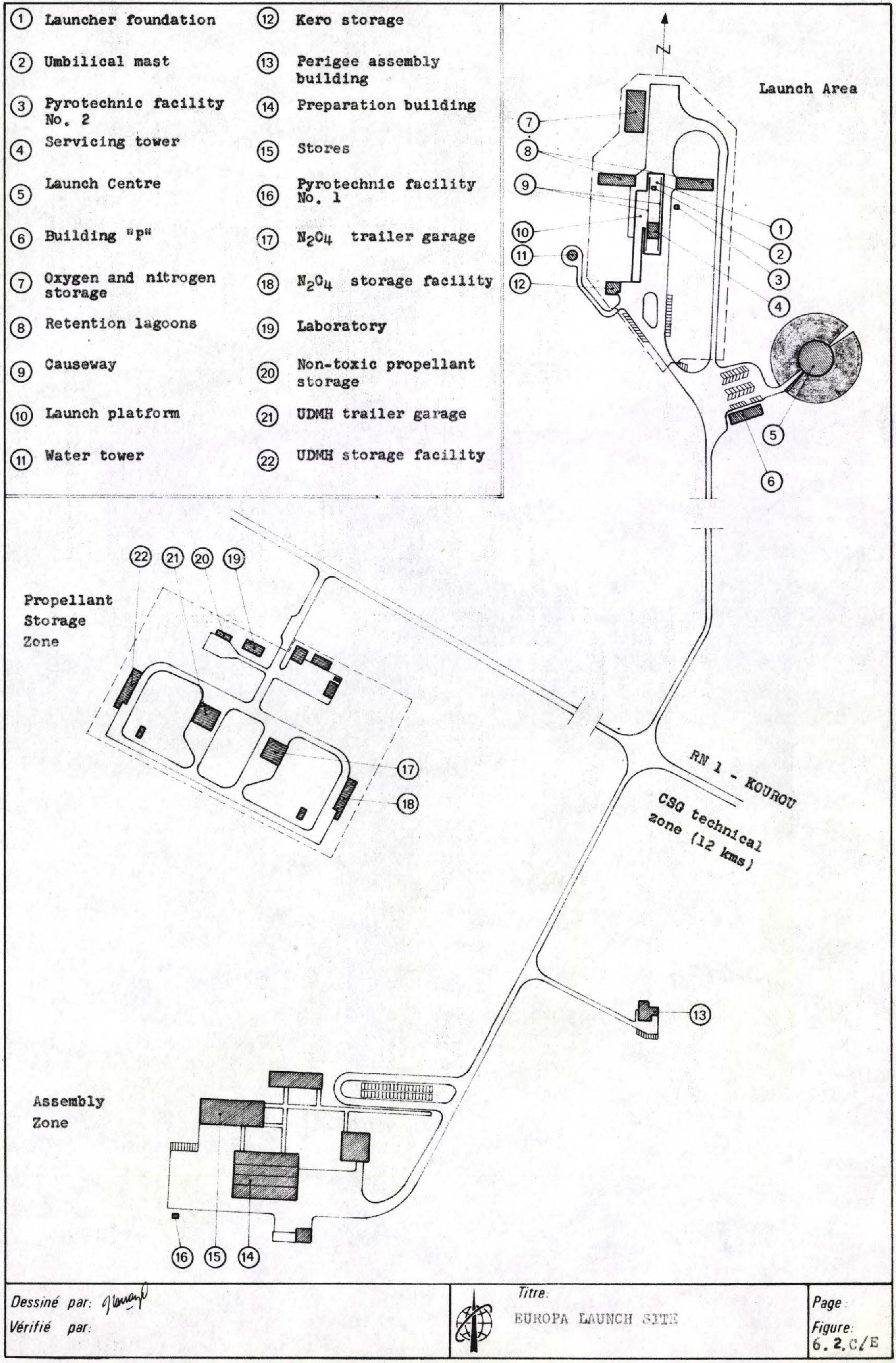

① Launcher foundation
② Umbilical mast
③ Pyrotechnic facility No. 2
④ Servicing tower
⑤ Launch Centre
⑥ Building "P"
⑦ Oxygen and nitrogen storage
⑧ Retention lagoons
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⑰ N_2O_4 trailer garage
⑱ N_2O_4 storage facility
⑲ Laboratory
⑳ Non-toxic propellant storage
㉑ UDMH trailer garage
㉒ UDMH storage facility

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Titre: EUROPA LAUNCH SITE

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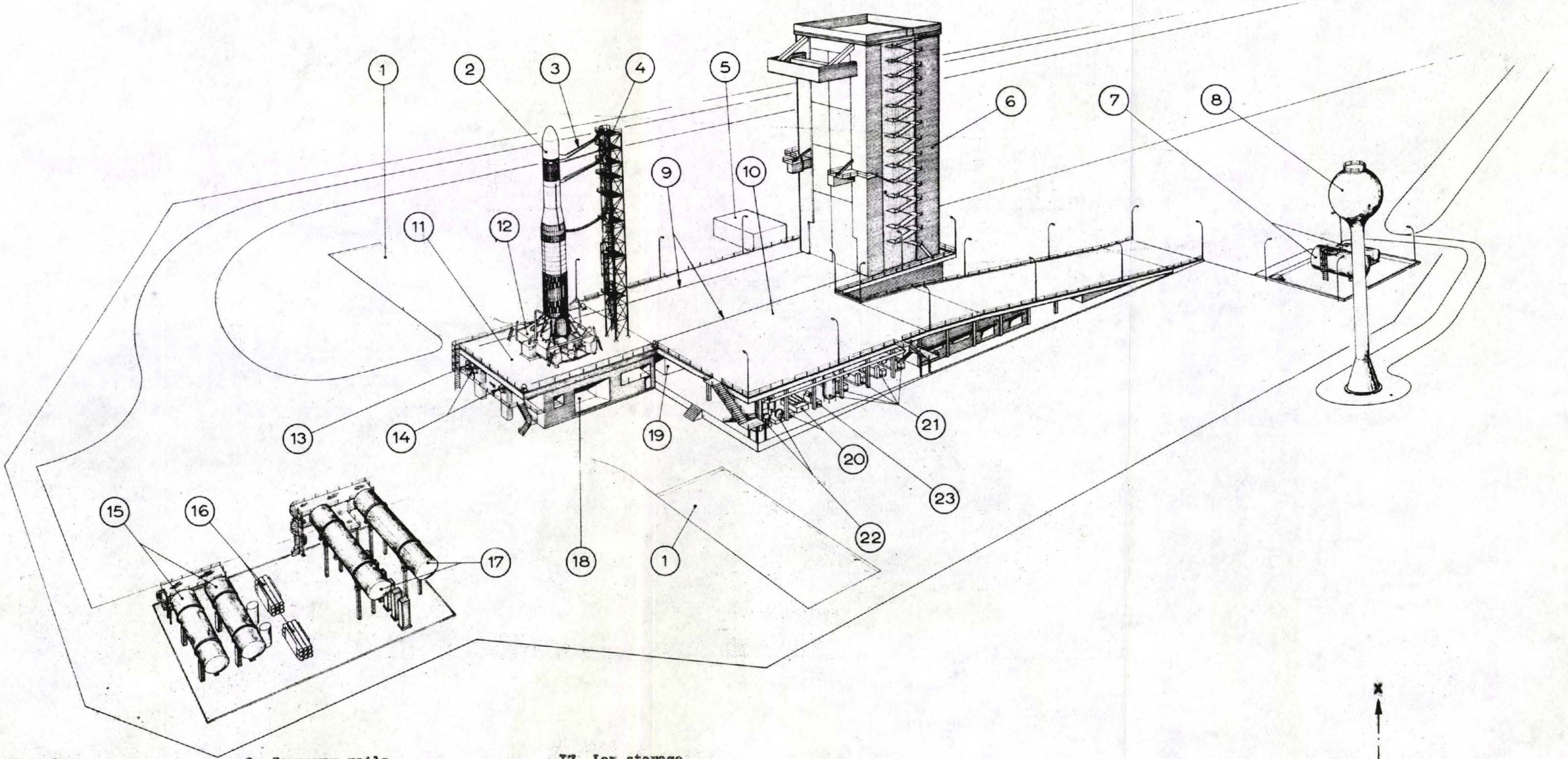
Figure: 6.2.C/E



I. Retention lagoons
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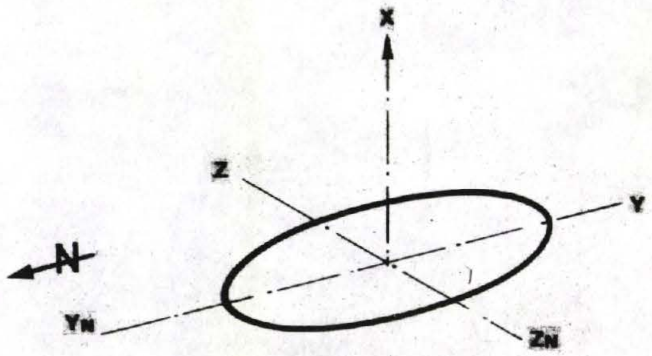
I4. Ist stage erection pivots
I5. Liquid nitrogen storage
I6. Gazeous nitrogen storage

I7. Lox storage
I8. Exhaust duct
I9. Forward test post
20. Cold air
2I. Compressed air
22. Scrubbers
23. Breathing air



Orientation du lanceur
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Vérifié par:

Titre:
EUROPA LAUNCH AREA

Page:
Figure:
6.2.D.

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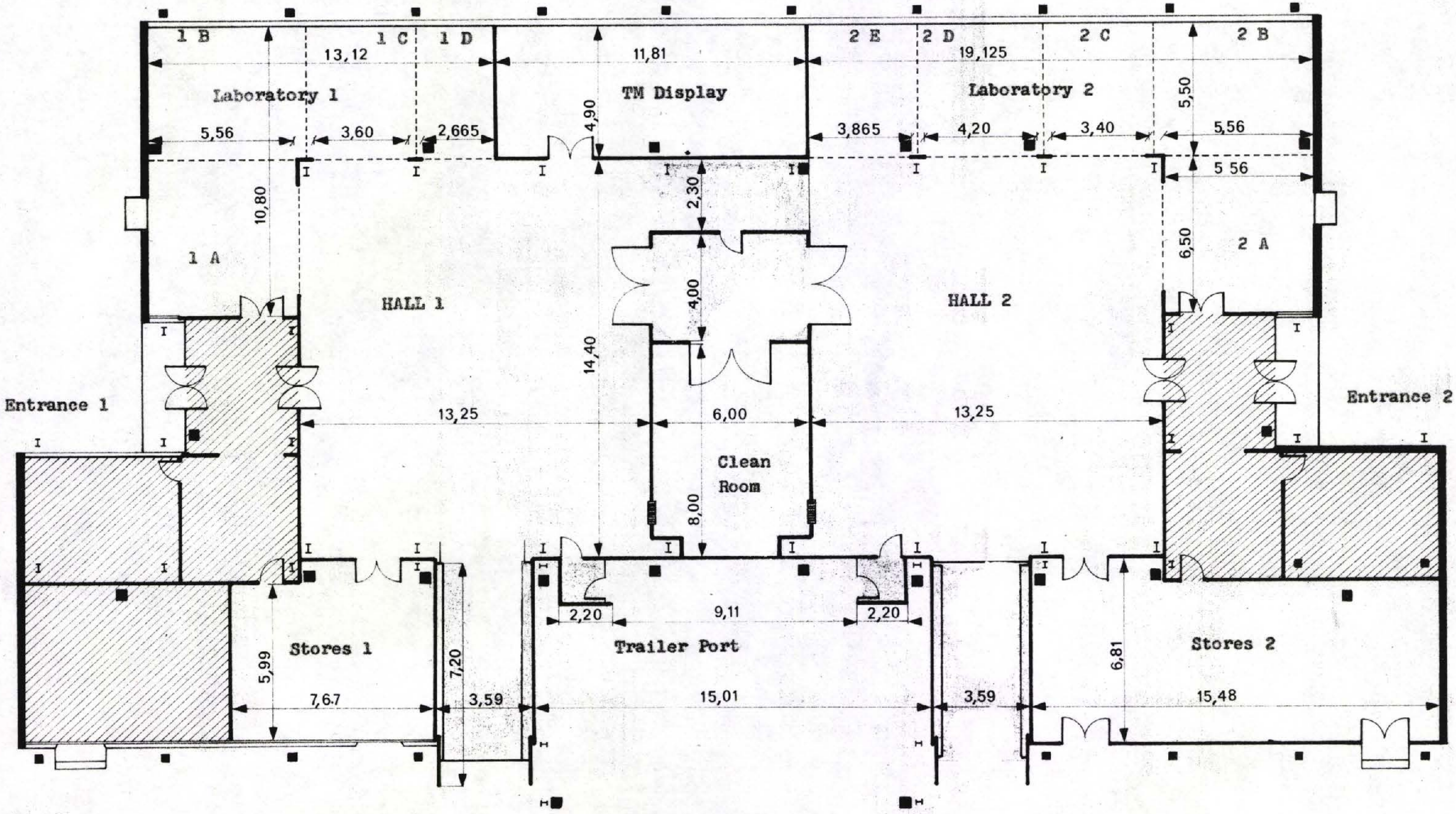
Titre:
TECHNICAL CENTRE
SATELLITE PREPARATION BUILDING

Page:
Figure:
6.5.A/B



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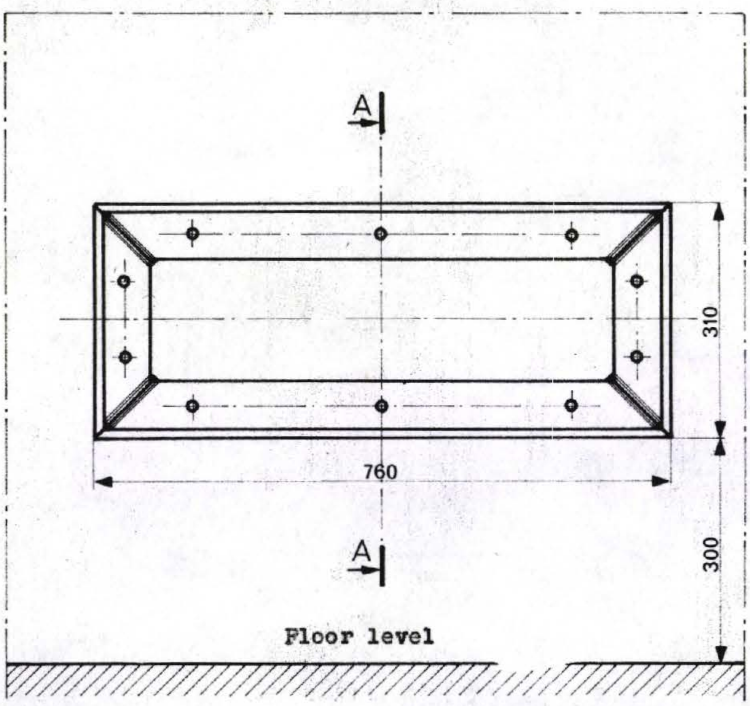
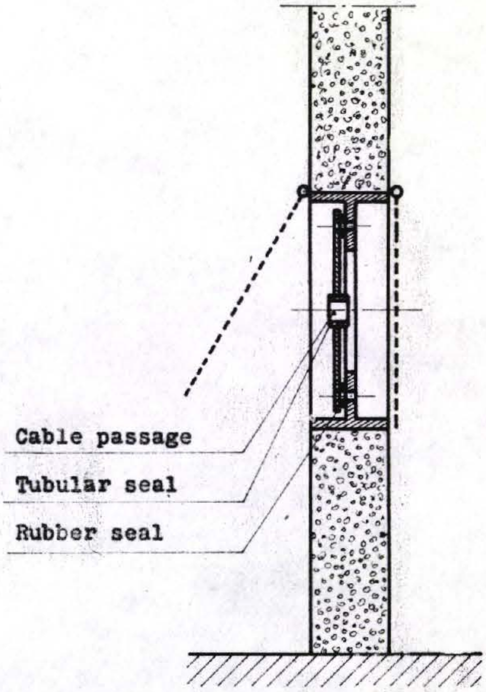


SECTION A



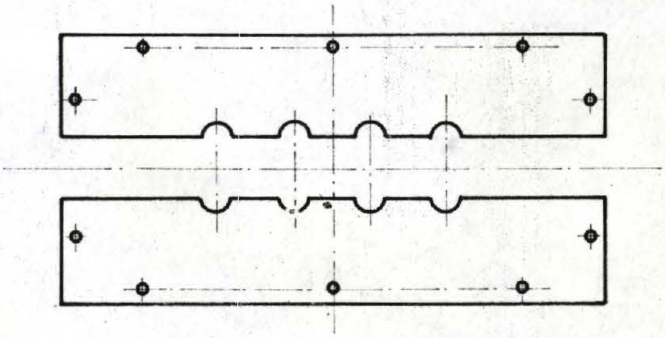


Plate cut to request

Number of ducts: 2

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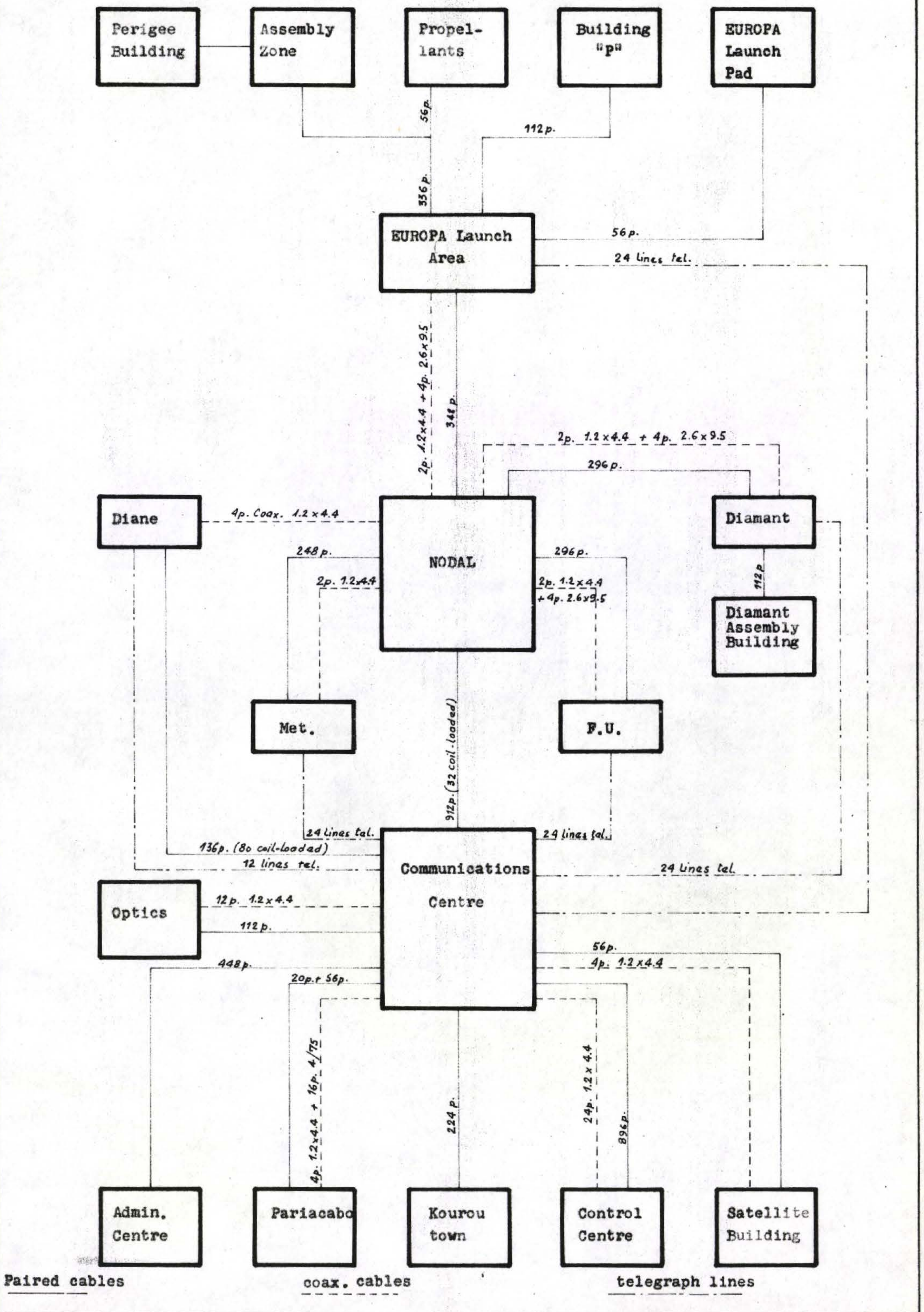
Titre:
CABLE PASSAGE TO CLEAN ROOM

Page:
Figure: 6.5.C.



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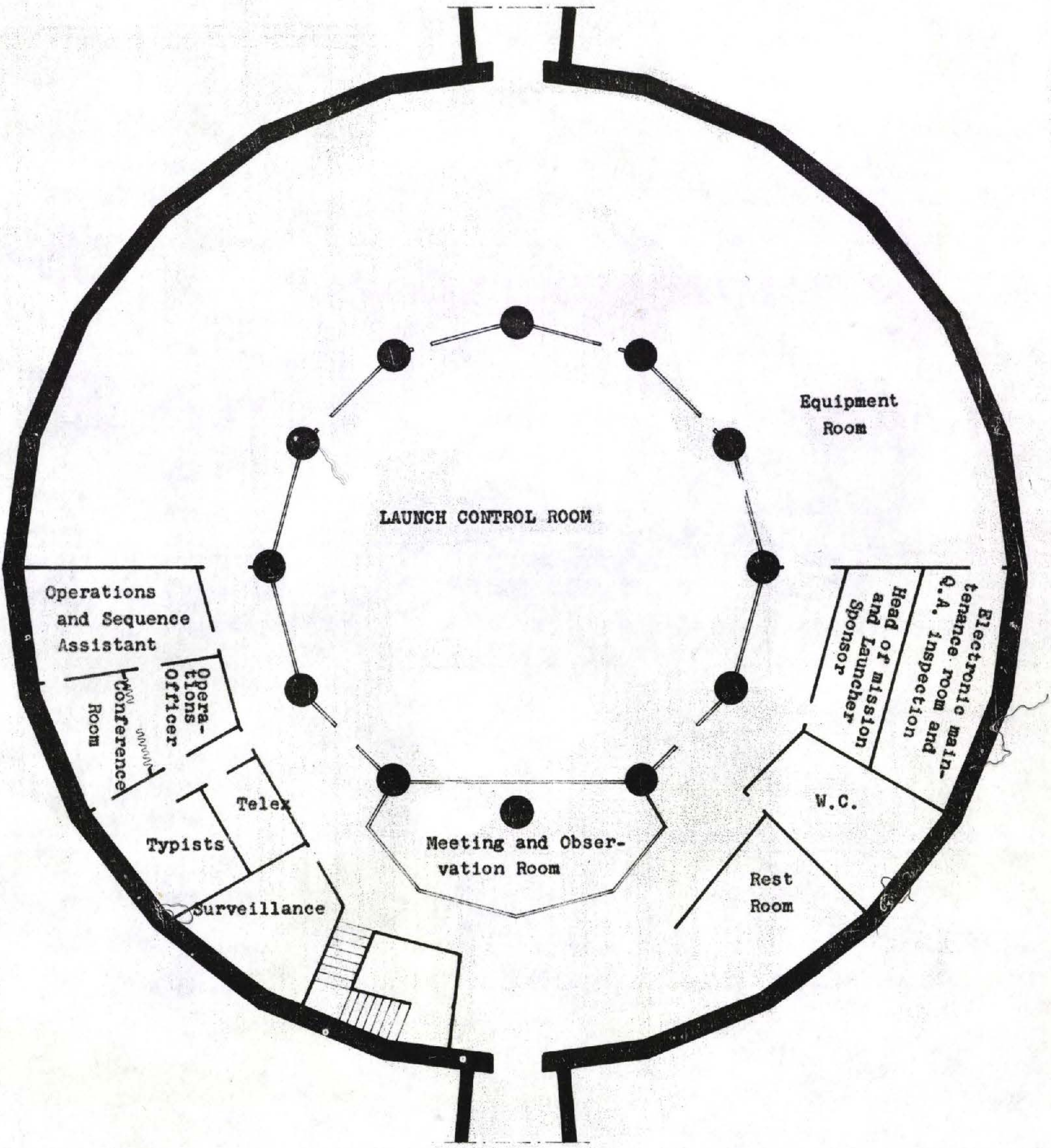
Vérifié par:

Titre:
SYNOPTIC CSG CABLING NETWORK

Page:
Figure: 6.5.E.


Equipment Room
LAUNCH CONTROL ROOM
Operations and Sequence Assistant
Opera-tions Officer
Conference Room
Telex
Typists
Surveillance
Meeting and Observation Room
Electronic maintenance room and Q.A. inspection
Head of mission and Launcher Sponsor
W.C.
Rest Room

Dessiné par:
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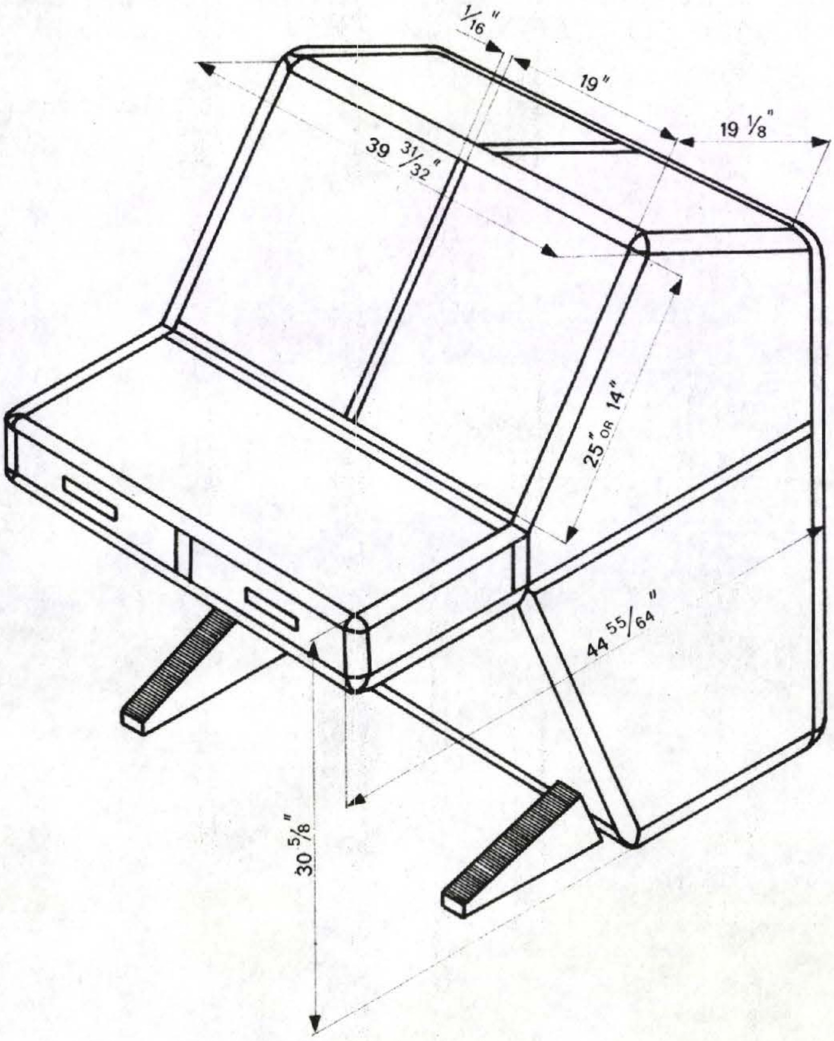
Titre:
EUROPA LAUNCH CENTRE

Page:
Figure: 6.6.A.



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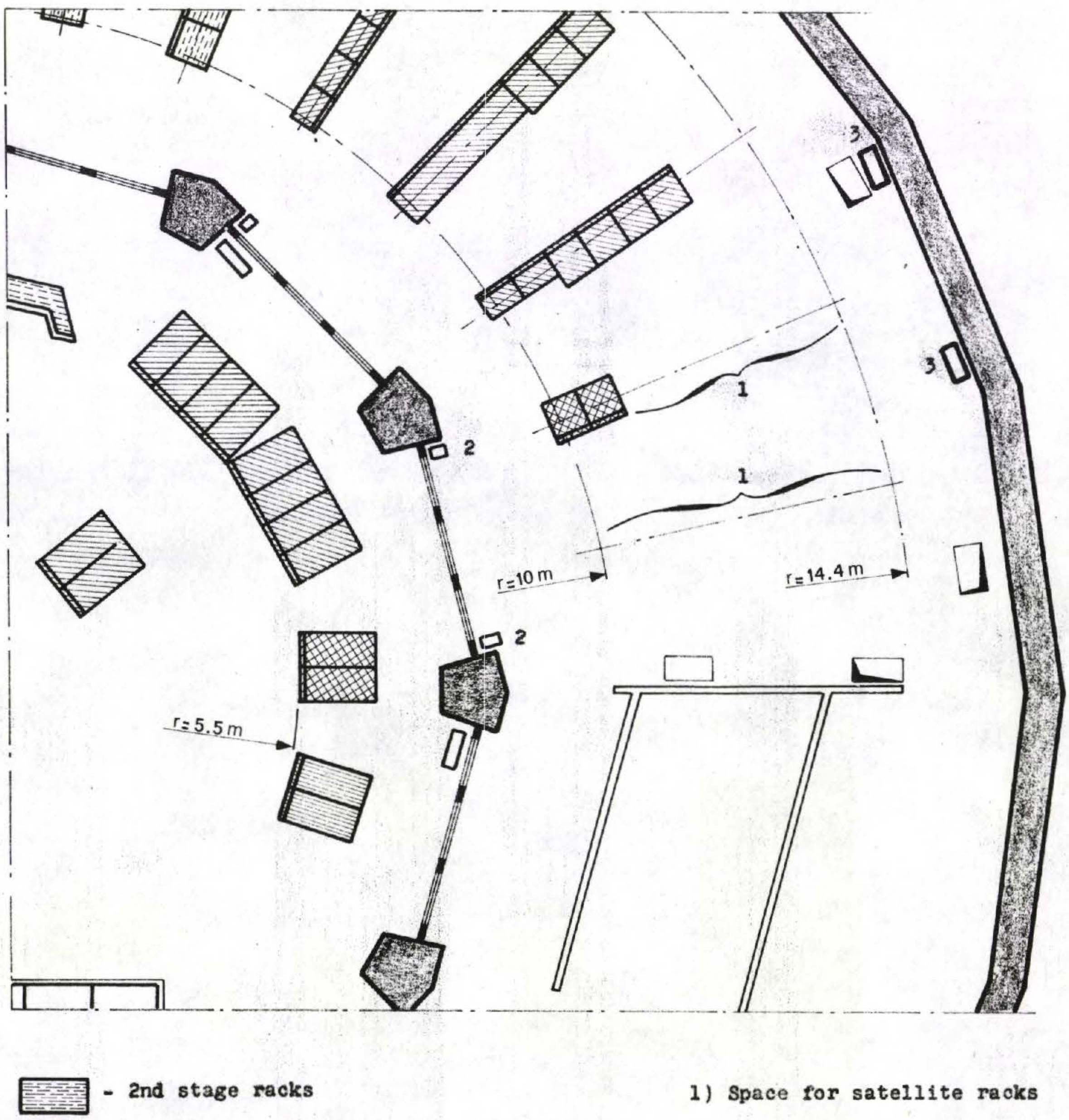
Titre:
SATELLITE OPERATING OFFICER'S CONSOLE

Page:
Figure: 6.6.B



▤ - 2nd stage racks

▨ - 3rd stage racks

▩ - 4th stage racks

▤ - Satellite Officer Console

1) Space for satellite racks

2) Earthed plugs

3) Plan of electrical plugs

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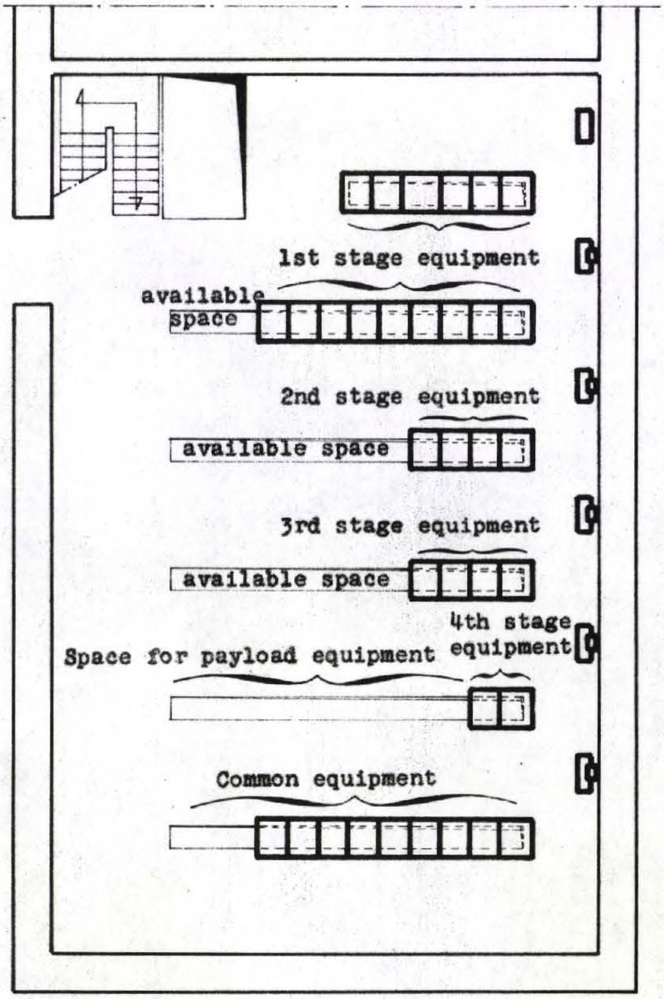
Titre:
LAUNCH CENTRE
SPACE OCCUPIED BY THE SATELLITE TEAMS

Page:
Figure:
6.6.C



Scale: 1/140

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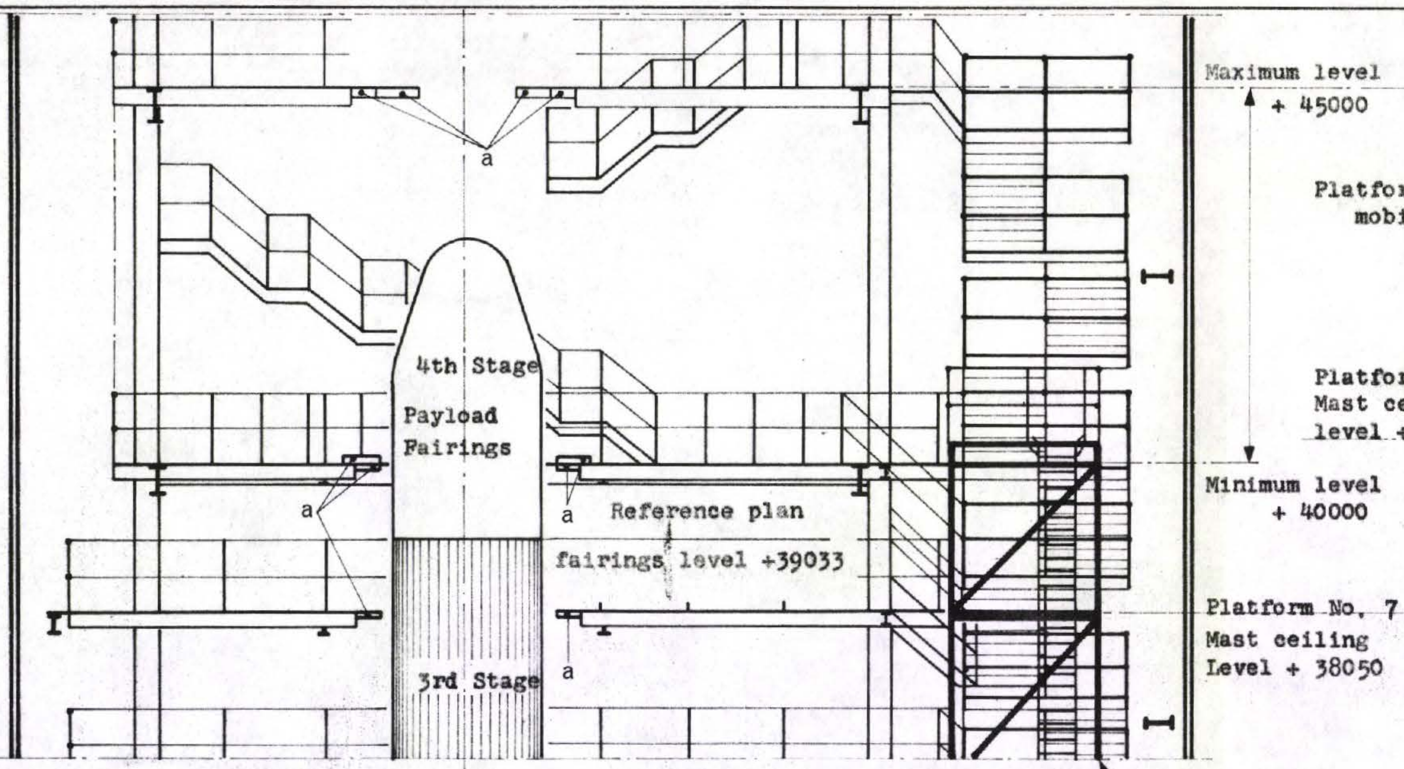
SERVICING TOWER

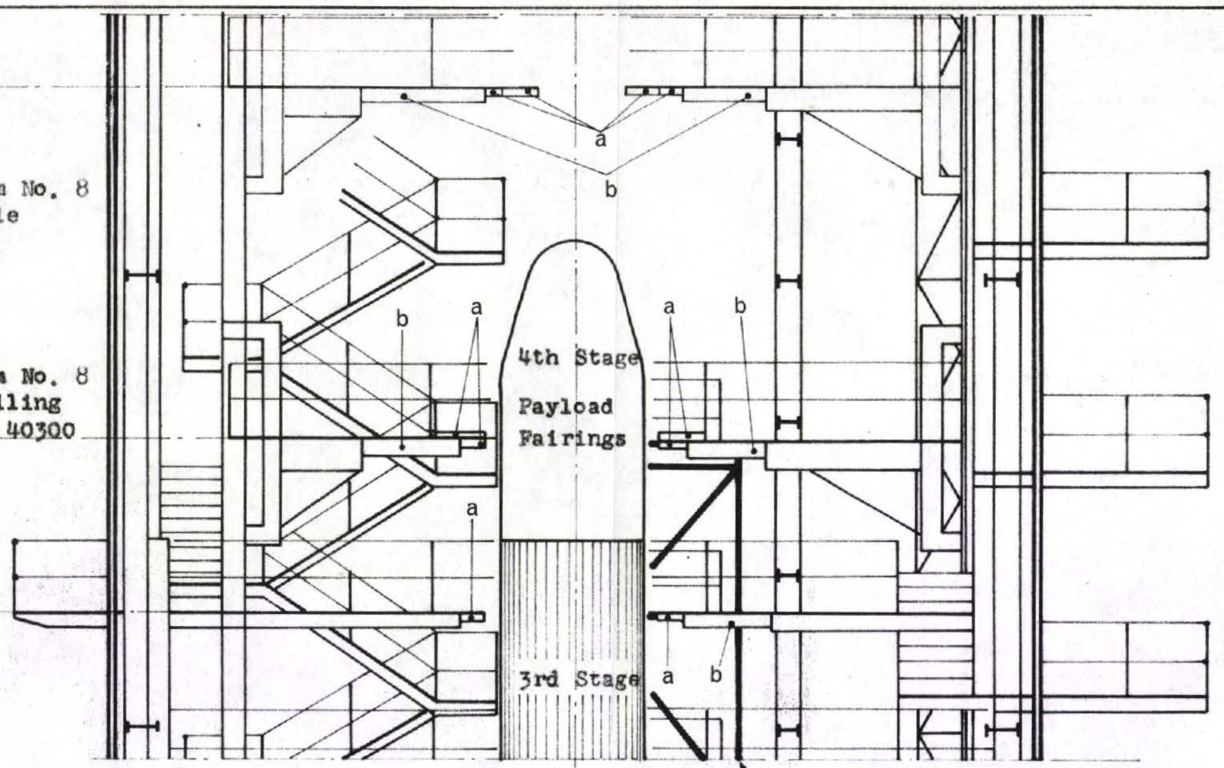
Sectional view of platforms 7 and 8



SECTION B - B

Platform No. 8 at its maximum level

a - removable flaps



SECTION A - A

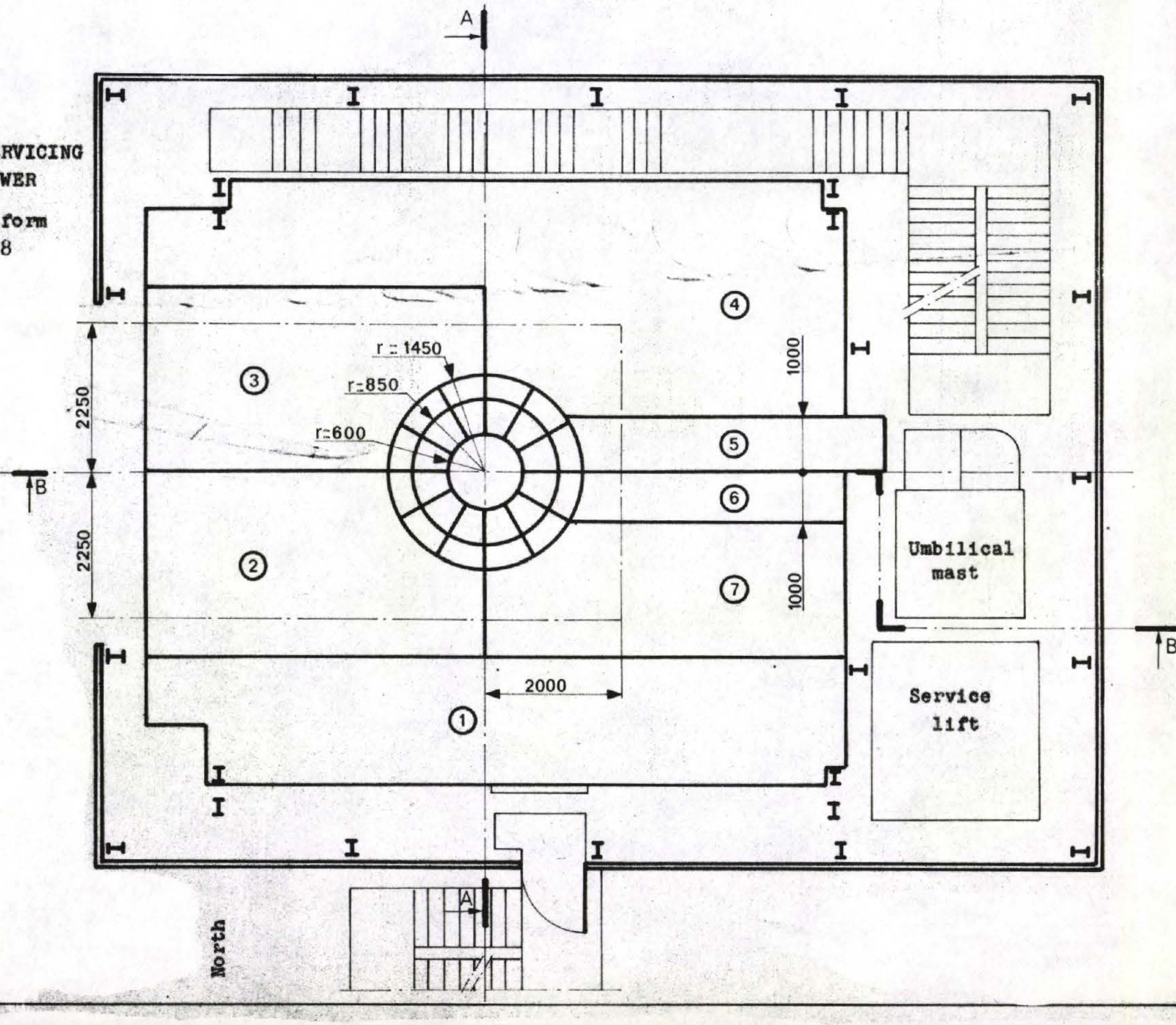
Platform No. 8 at EUROPA II working level

a - removable flaps

b - folding sections

SERVICING TOWER

Platform No. 8



Platform No. 8 - Levels: +40000 to +45000

1, 4 - non folding sections

2, 3, 5, 6, 7 - folding sections

a, b - removable flaps

//// - Area serviced by the gantry hook

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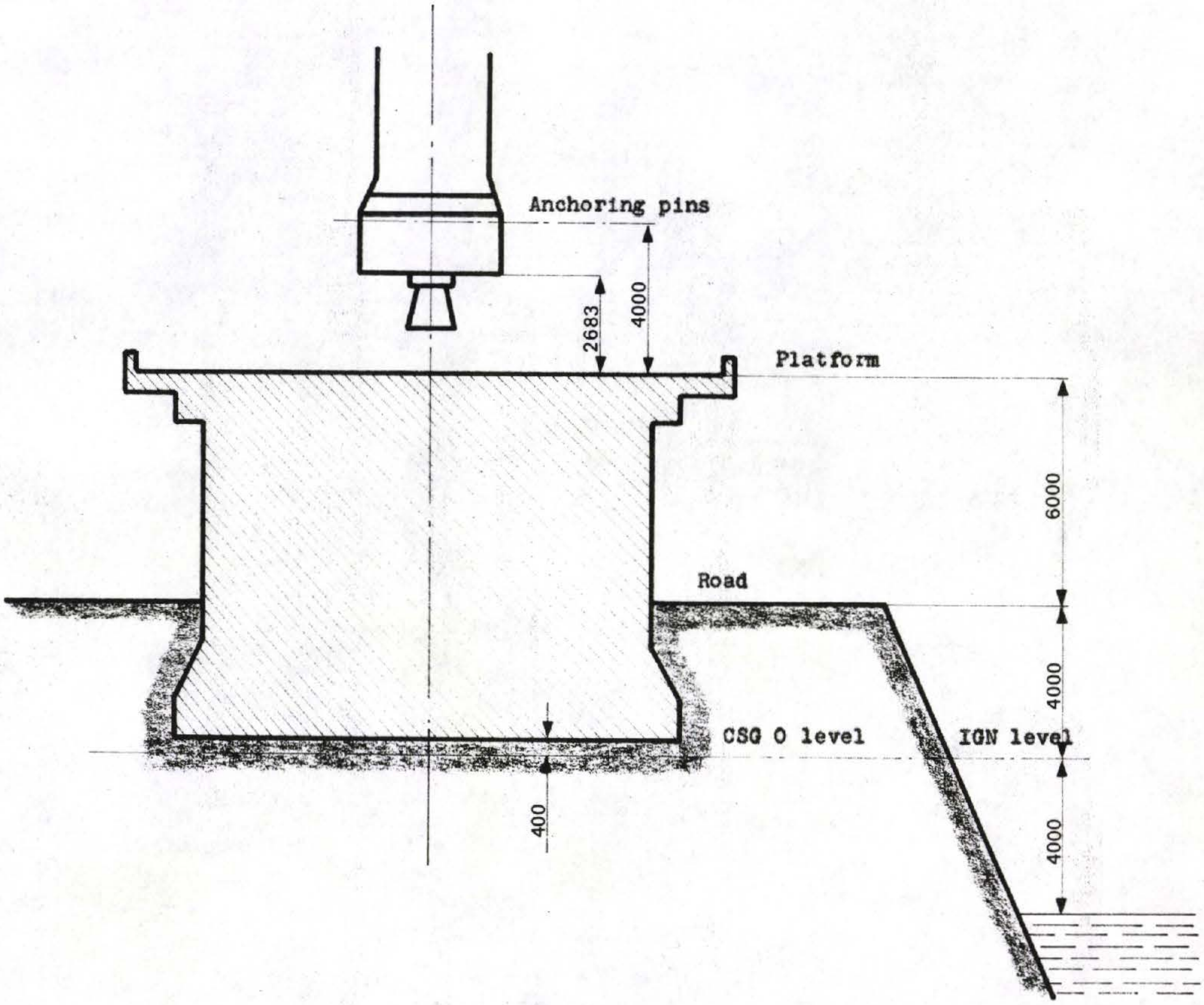

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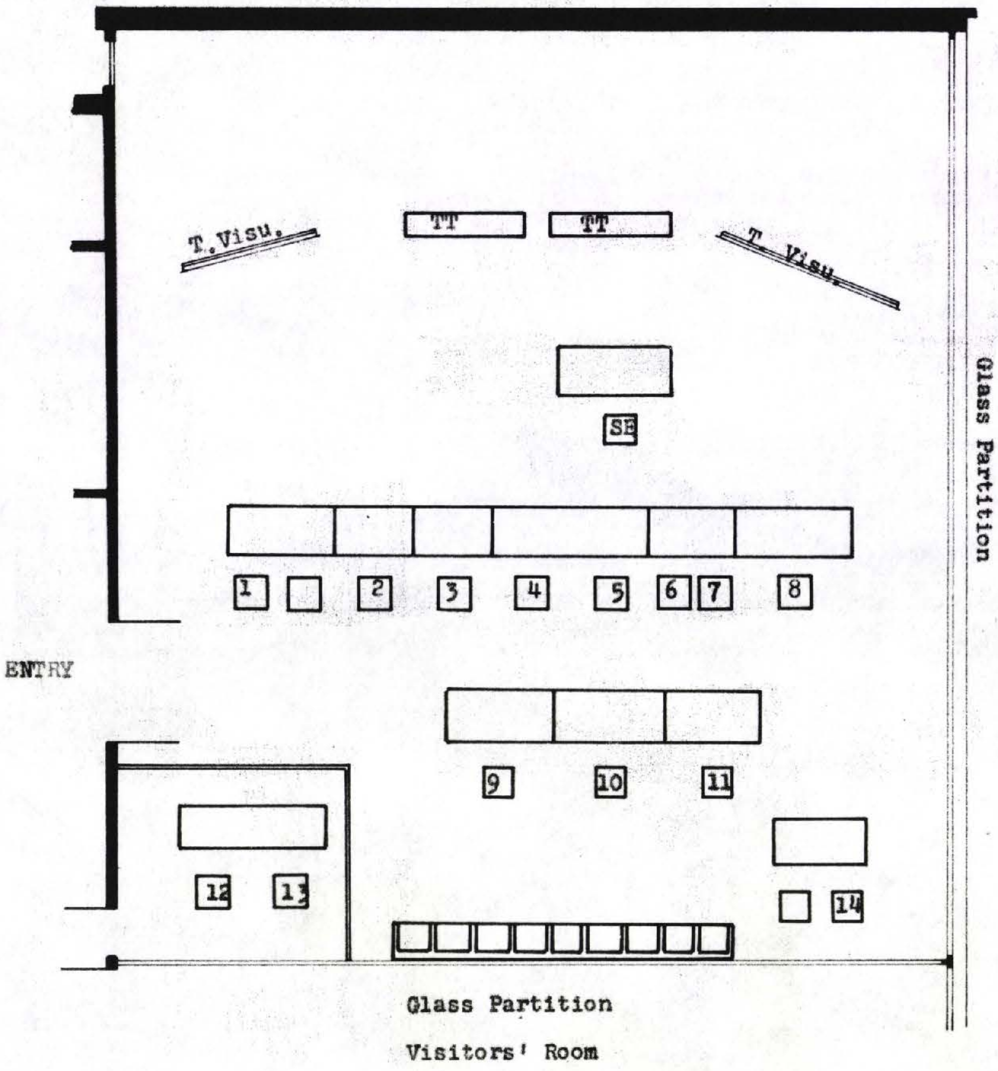
Titre:
EUROPA SERVICING TOWER
REFERENCE LEVELS

Page:
Figure: 6.8.D.

T.T.: Plotting table
T. Visu.: Display panel
S.E.: Technical secretary



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Vérifié par:

Titre: CONTROL CENTRE

Page:
Figure: 6.9.A

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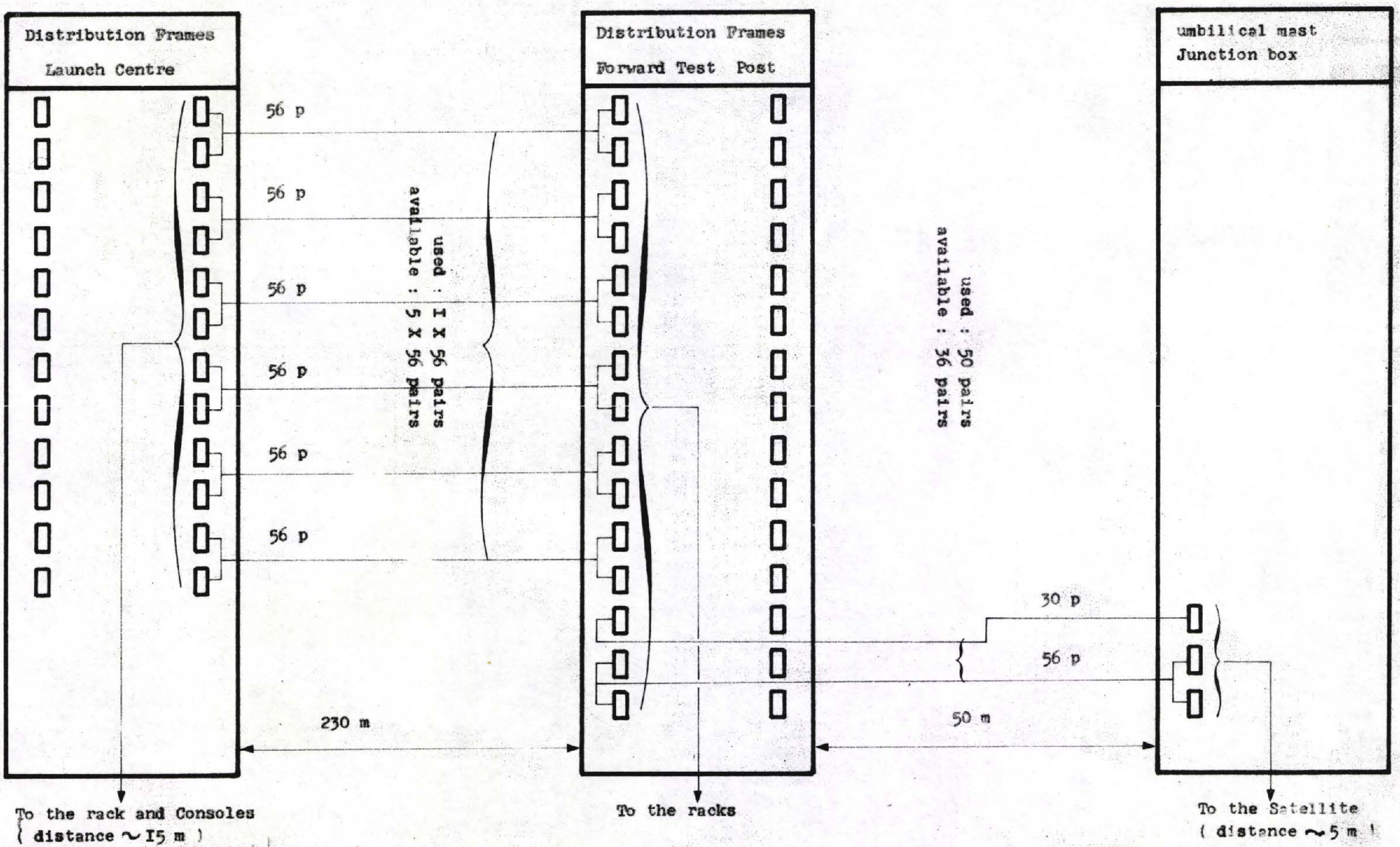
Titre: Diagram of functional Satellite links on the ELE.



VERY IMPORTANT : The lenghts are given as guidance and cannot be used for the manufacture of the Satellite links

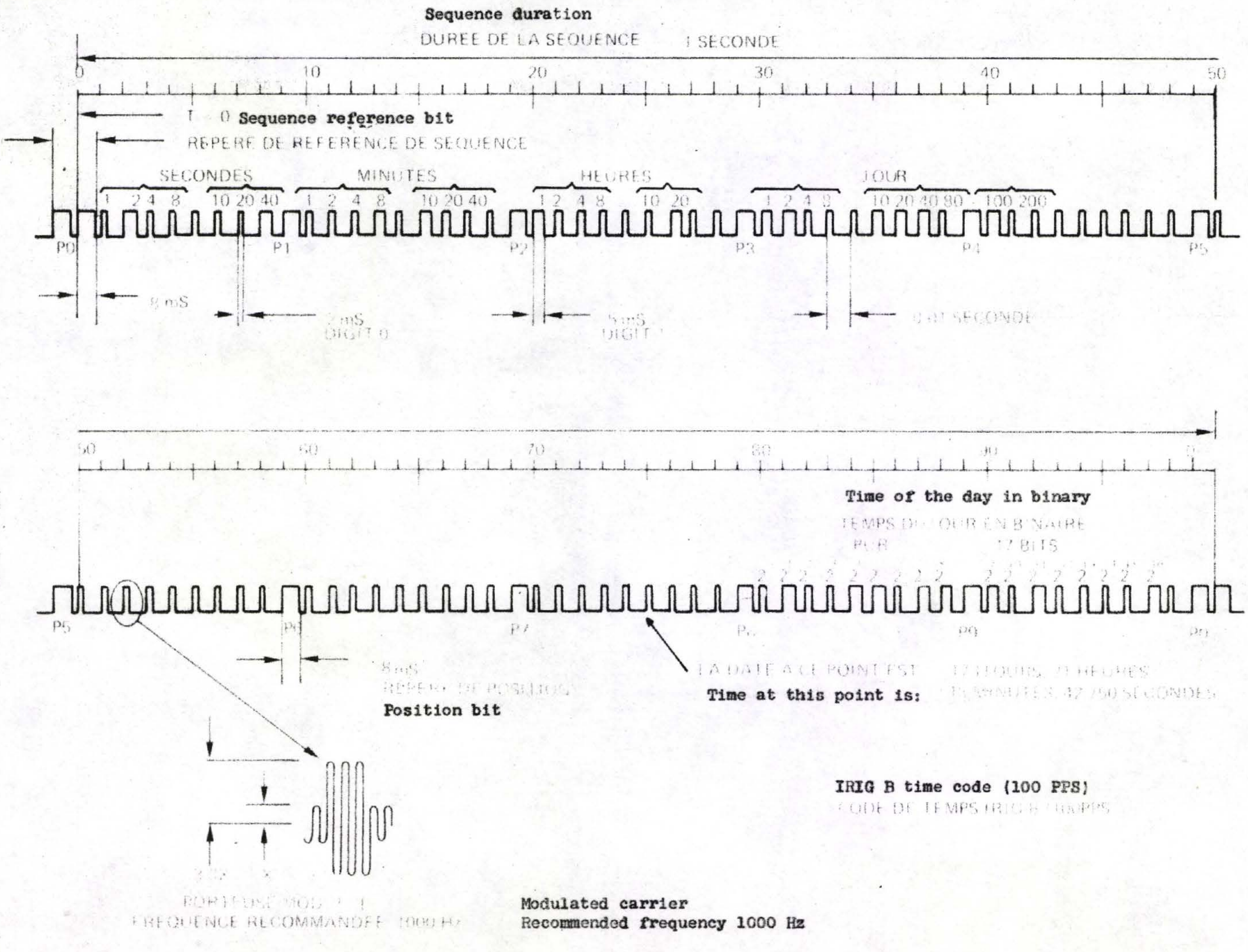
☐ Connecting strips " POUYET".

Page A L. 0

Figure: 6.10.A.

Dessiné par

Vérifié par

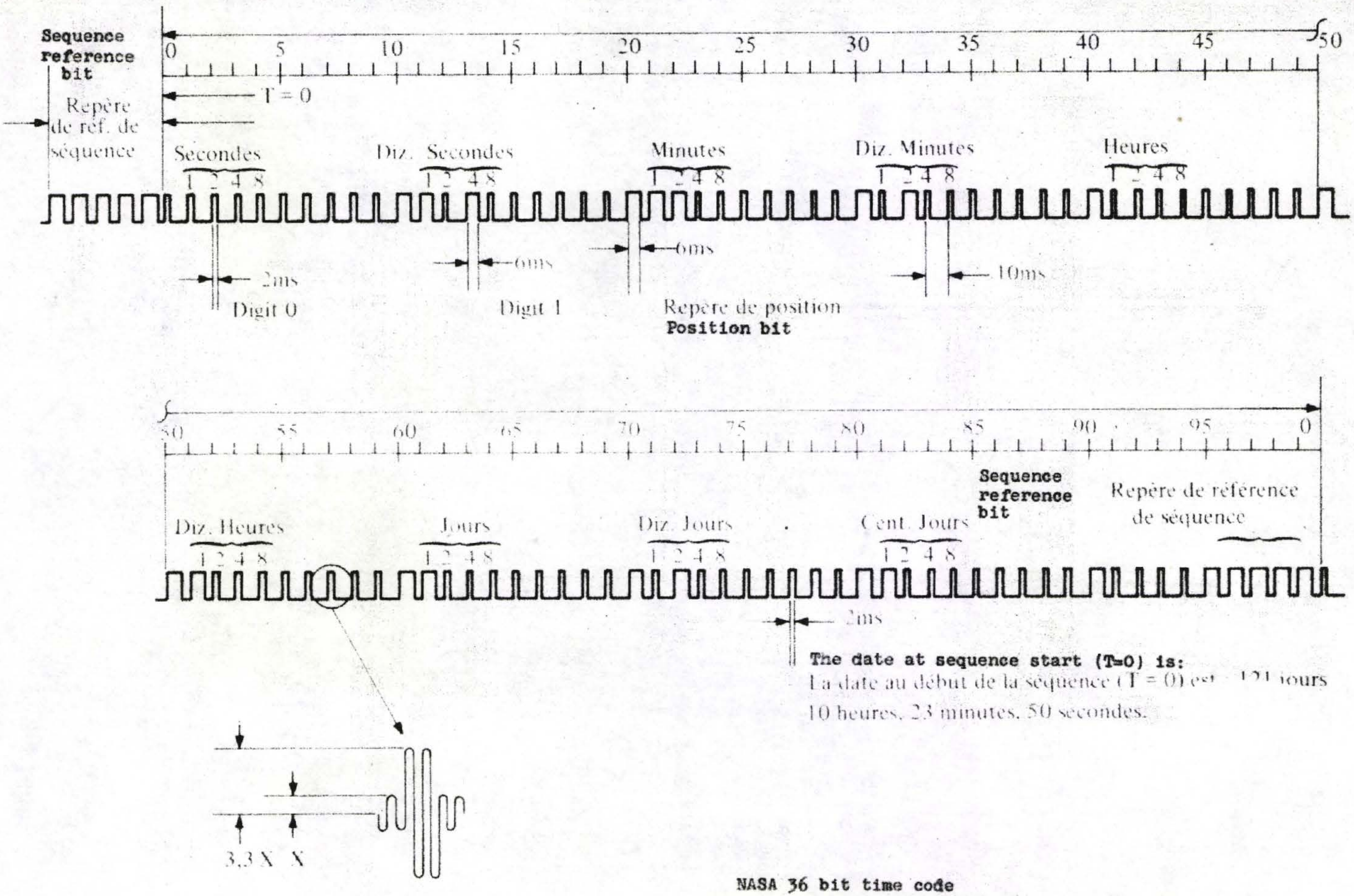


IRIG B time code (100 PPS)

CODE DE TEMPS IRIG B 100PPS

Titre
IRIG B TIME CODE

Page
Figure
6.12.A

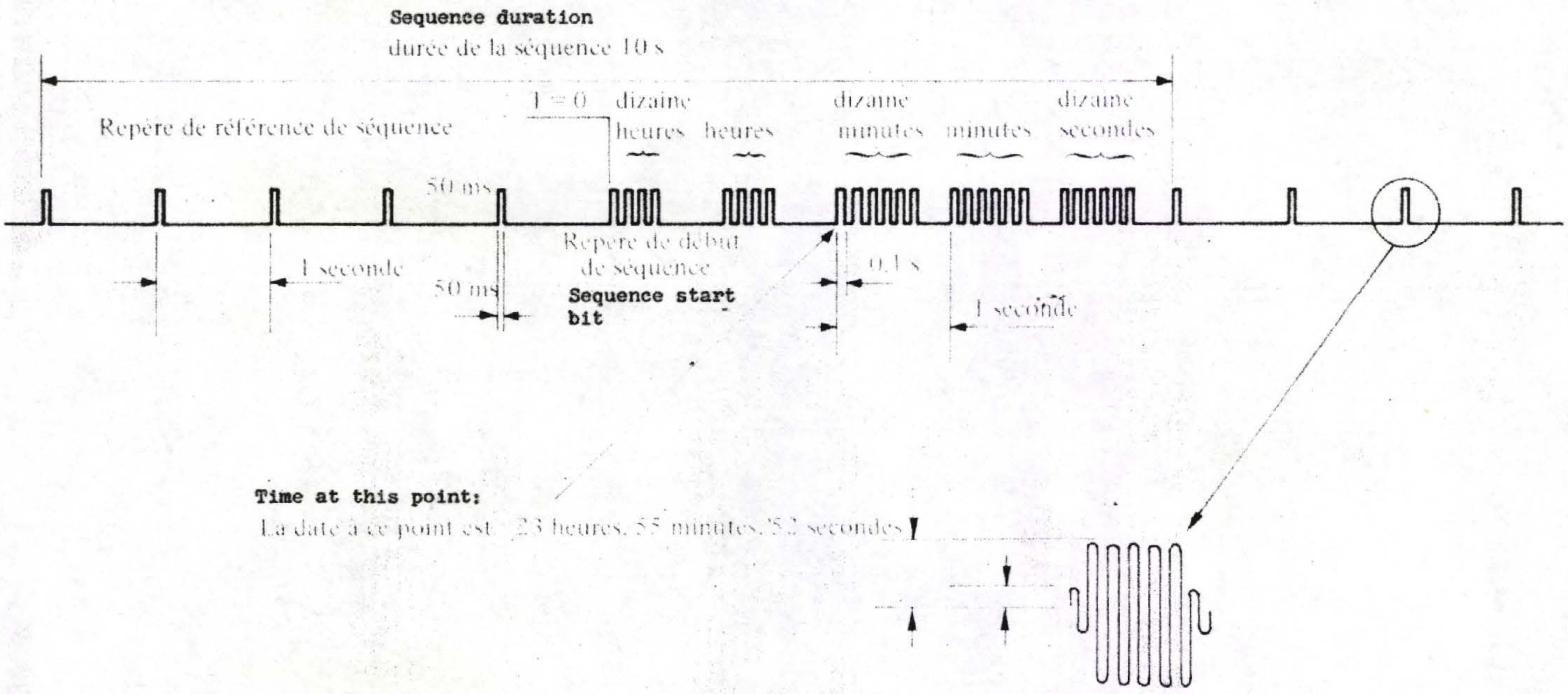


The date at sequence start (T=0) is:
La date au début de la séquence (T = 0) est 121 jours 10 heures, 23 minutes, 50 secondes.

Porteuse modulée
Fréquence recommandée 1000 Hz
Modulated carrier
Recommended frequency 1000 Hz

NASA 36 bit time code
Code de temps NASA 36 bits

Déssiné par: Manard
Vérifié par:
Titre: NASA 36 BIT TIME CODE
Page:
Figure: 6.12.B



PADTC time code (10 PPS)

CODE DE TEMPS PADTC (10 pps)

Dessiné par:
Vérifié par:

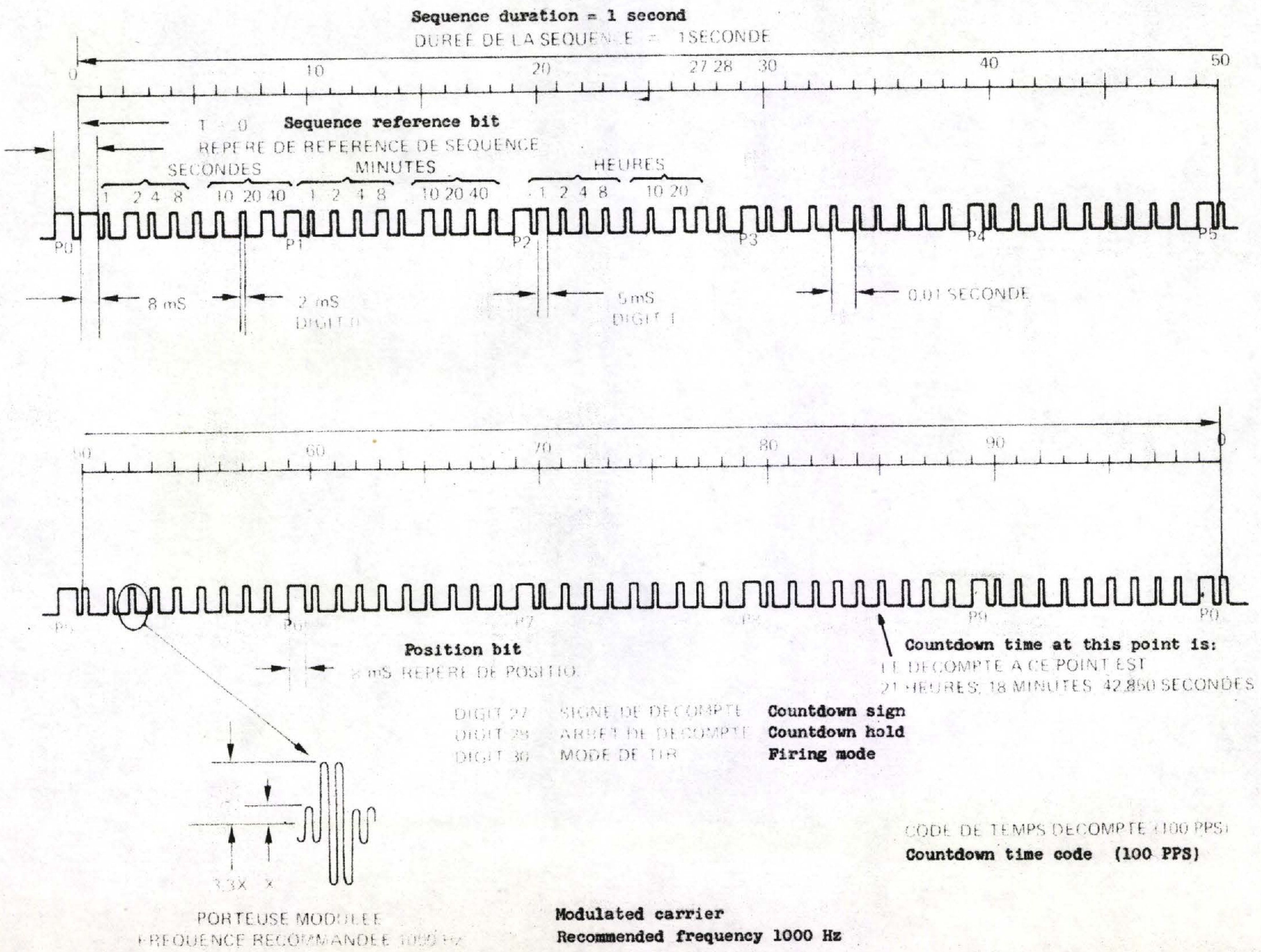
Titre:
PADTC TIME CODE

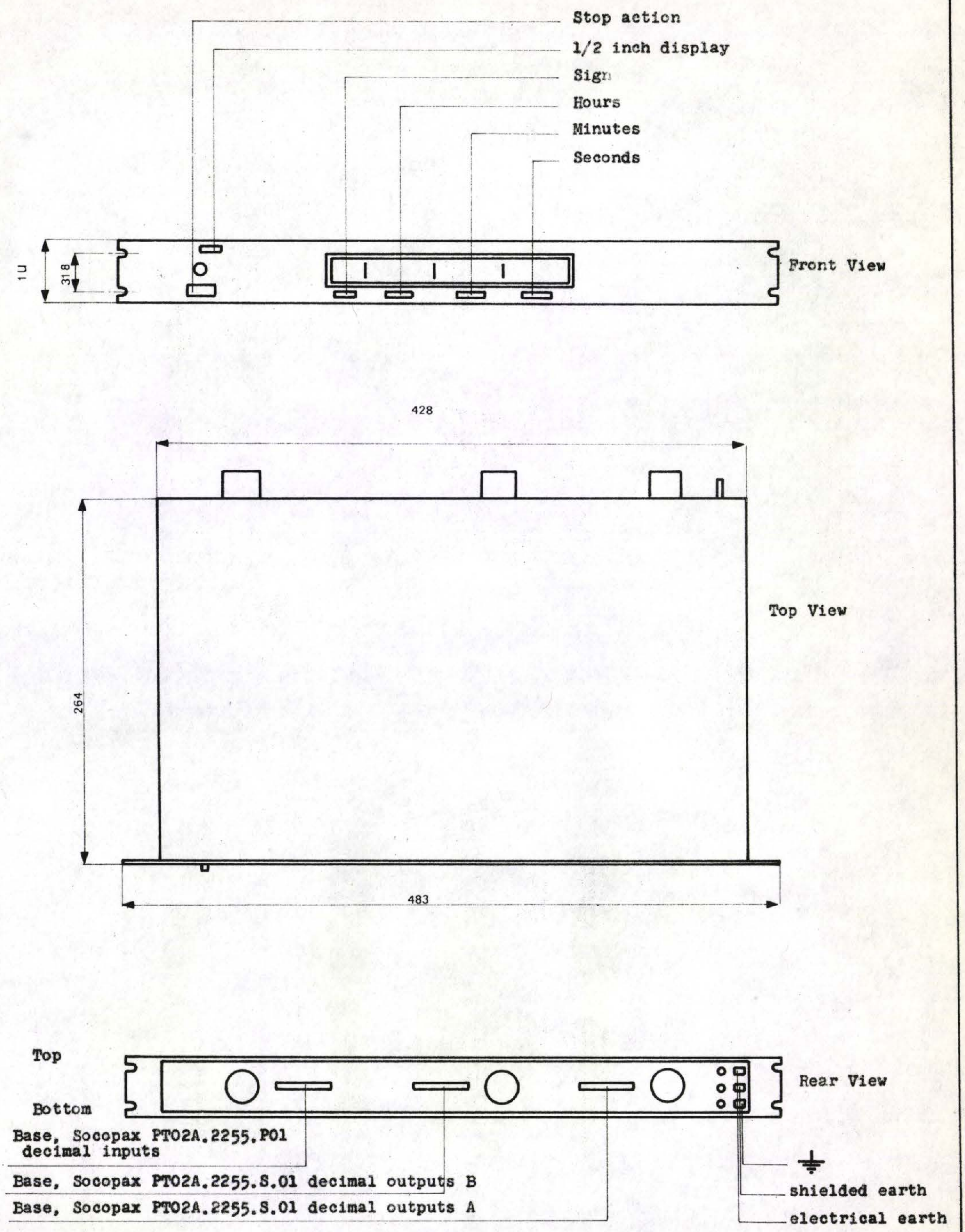
Page:
Figure:
6.12.C

Dessiné par:
Vérifié par:

Titre: COUNTDOWN TIME CODE

Page:
Figure: 6.12. D


Sequence duration = 1 second
DUREE DE LA SEQUENCE = 1SECONDE
0
10
20
27 28
30
40
50
T = 0
Sequence reference bit
REPERE DE REFERENCE DE SEQUENCE
SECONDES
1 2 4 8
10 20 40
MINUTES
1 2 4 8
10 20 40
HEURES
1 2 4 8
10 20
P0
P1
P2
P3
P4
P5
8 mS
2 mS
DIGIT 0
5 mS
DIGIT 1
0,01 SECONDE
50
60
70
80
90
0
P5
P6
P7
P8
P9
P0
Position bit
8 mS REPERE DE POSITIO.
Countdown time at this point is:
LE DECOMPTE A CE POINT EST
21 HEURES, 18 MINUTES 42,850 SECONDES
DIGIT 27 SIGNE DE DECOMPTE Countdown sign
DIGIT 28 ARRET DE DECOMPTE Countdown hold
DIGIT 30 MODE DE TIR Firing mode
3,3X
X
PORTEUSE MODULEE
FREQUENCE RECOMMANDEE 1000 Hz
Modulated carrier
Recommended frequency 1000 Hz
CODE DE TEMPS DECOMPTE (100 PPS)
Countdown time code (100 PPS)


Stop action
1/2 inch display
Sign
Hours
Minutes
Seconds
1U
318
Front View
428
264
Top View
483
Top
Bottom
Rear View
Base, Socopax PTO2A.2255.P01 decimal inputs
Base, Socopax PTO2A.2255.S.01 decimal outputs B
Base, Socopax PTO2A.2255.S.01 decimal outputs A
shielded earth
electrical earth

Dessiné par:
Vérifié par:

Titre: 1/2" DISPLAY UNIT

Page:
Figure: 6.12.E

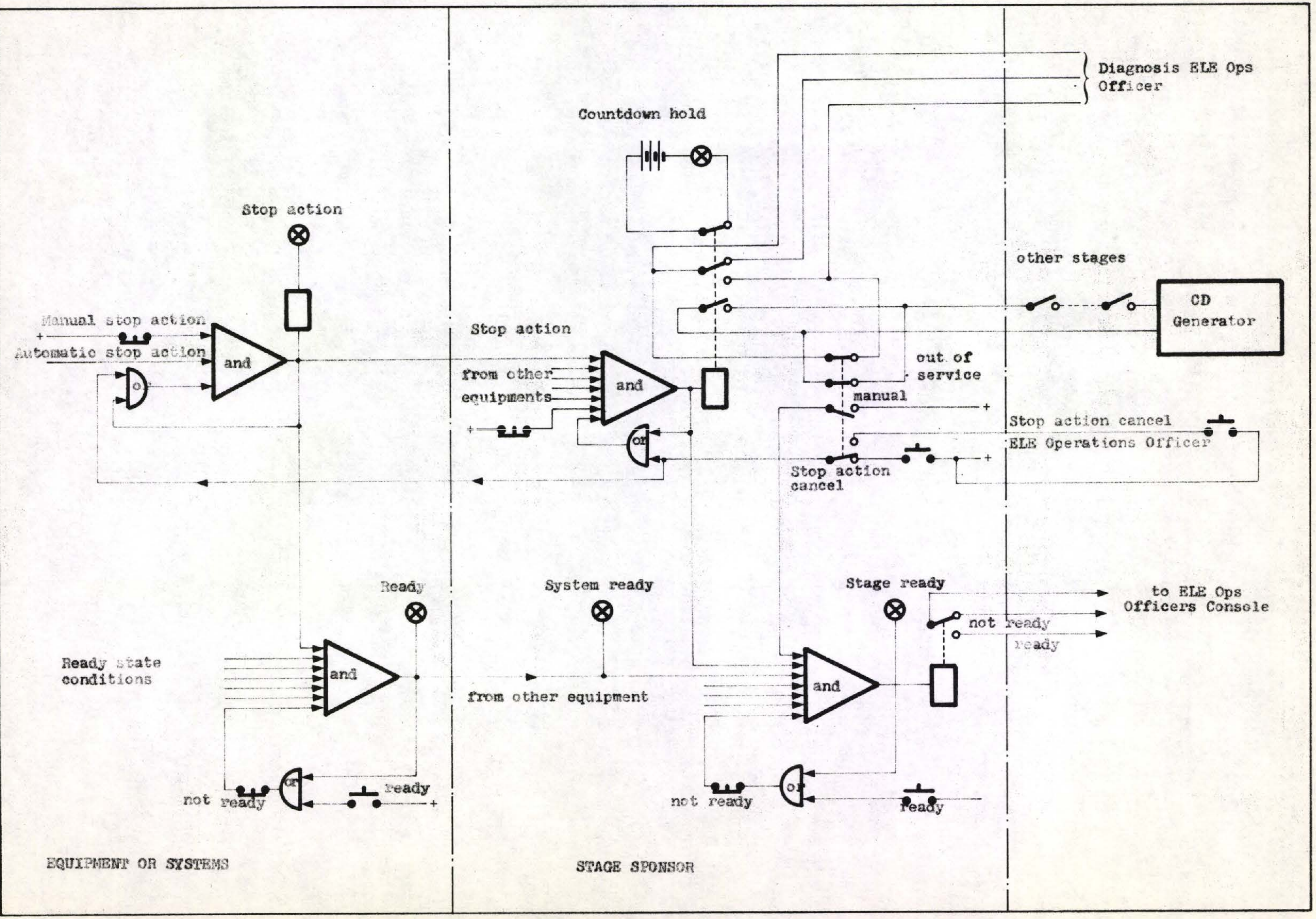
Dessiné par:

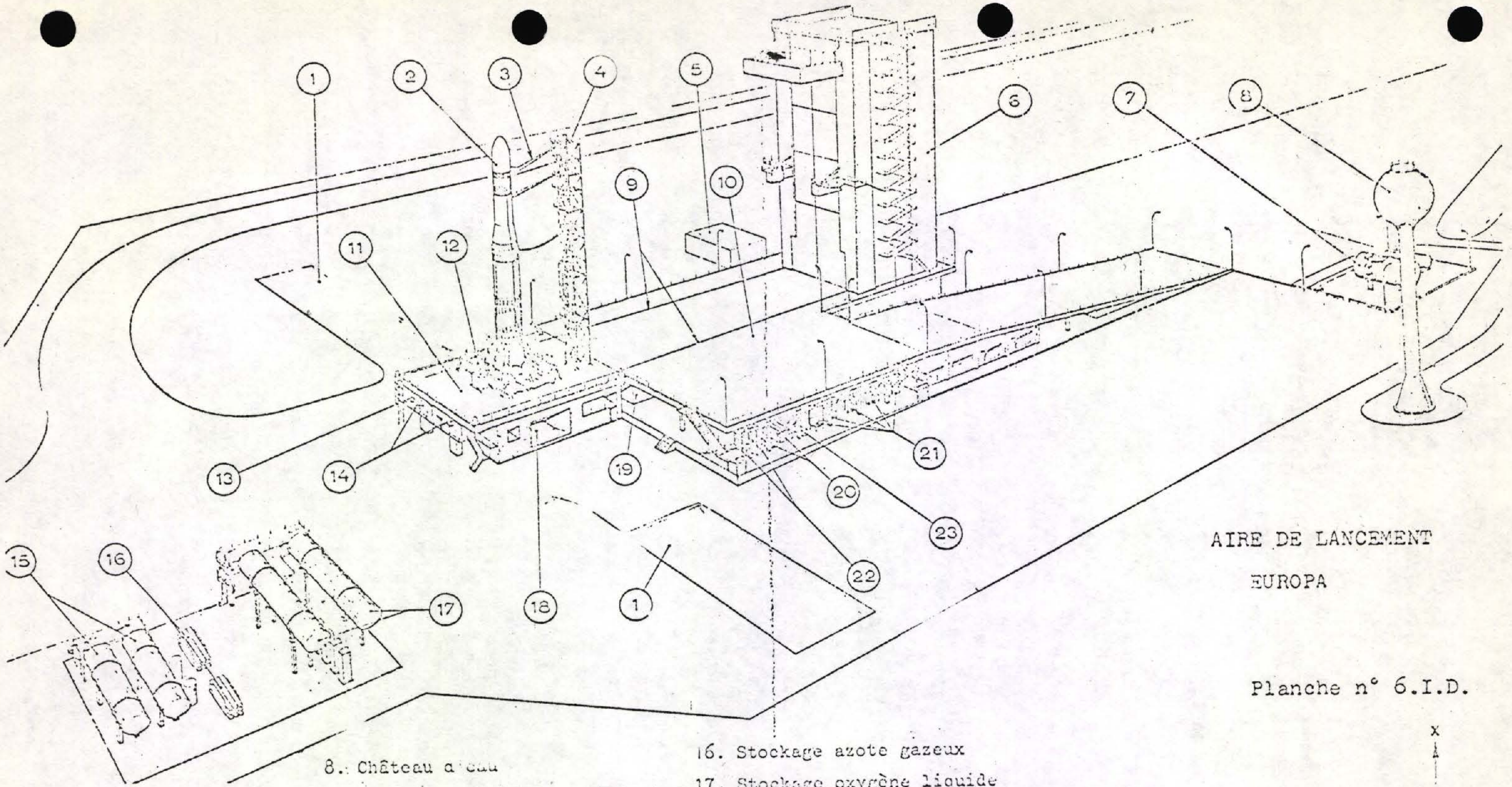
Vérifié par:

Titre: SCHEMATIC OF STOP ACTION AND READY SIGNAL CIRCUITS

Page:

Figure: 6.13.A.



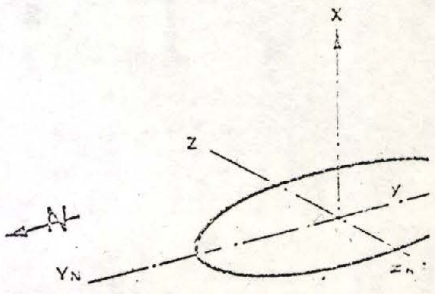


AIRE DE LANCEMENT

EUROPA

Planche n° 6.I.D.

1. Bassins de retention
2. Lanceur Europa II
3. Câbles ombilicaux
4. Mât ombilical
5. Local pyro n° 2
6. Tour de montage
7. Stockage kérosène
8. Château d'eau
9. Rails du chemin de roulement
10. Plateforme de lancement
11. Massif
12. Table de lancement
13. Stockage trichloroéthilène
14. Pivots d'érection 1° étage
15. Stockage azote liquide
16. Stockage azote gazeux
17. Stockage oxygène liquide
18. Déflecteur de jet
19. Poste de contrôle avancé (P.C.A.)
20. Air de refroidissement
21. Air comprimé
22. Neutraliseurs
23. Air respirable



Orientation du lanceu
sur la table de lanceme

7. RANGE OPERATIONS

7.1 Introduction

7.2 Logistic

7.3 General Information on the Operation of a European Launch Vehicle

7.4 Payload Aspects

7.5 Control of personnel admittance and movements

7.6 Restriction on electrical connection of the payload

CHAPTER 7 - RANGE OPERATIONS

7.1 Introduction

The description of French Guiana Range Operations for the ELDO vehicle, as given in this Chapter, is based on preliminary planning information for the non-flight site proving vehicle, designated MSRV (Multistage Reference Vehicle).

The vehicle and site preparation programmes which are summarised herein are based on previous test programmes in Woomera, Australia, and have been improved and modified as a result of recommendations from test and design personnel, and to conform with the new programme and site requirements.

There will be further improvements and modifications as operational flight vehicle programmes are developed, and any assessment or commitment based on this description should take the point into account.

7.2 Logistics

The basis for all Guiana ELDO programmes is a five day working week, each day having nominally eight hours' duration with Saturdays, Sundays and French national holidays normally involving a Range stand-down. A single shift capability for all ELDO and CSG support teams is envisaged. The vehicle preparation programme is given in the Detailed Launch Plan (DLP), a typical extract being attached as Annex 1. The corresponding site systems preparation programme is given in the Detailed Site Plan (DSP), an extract being attached as Annex 2.

All commitments for teams and support groups are listed in the DLP against calendar dates and L minus days. The latter references commence with the arrival of, usually, the 1st stage on site, and continue consecutively in descending order to the pre-launch day (L-1) and the Launch Day (L Day). All weekends and holidays are included in this reference system.

Individual blocks of work, both of a stage and an integrated nature, are further identified by phases. Thus Phase 2B refers to the 2nd stage activities immediately following erection and 2B-1 the second to last day of work in this phase. Weekends and holidays are not included in this reference system.

Accommodation, messing, transportation, medical services and travel arrangements may all be arranged through the ELDO Administrative Offices in Guiana as well as the normal advance reservations through ELDO Headquarters, Neuilly.

7.3 General Information on the Operation of a Europa Launch Vehicle

The sequence of prelaunch operations for a Europa II vehicle comprises the following phases :

a) ELE preparation

b) individual preparation of stages and payload

c) erection of vehicle and payload

d) overall launch vehicle checkout

e) launch preparation (countdown)

f) automatic sequence and launch

g) ELE revalidation.

The main points in these phases are included in the overall chronology which also refers to associated events outside the ELE.

7.3.1 ELE Preparation

To ensure correct working of the ground facilities and equipment and their compatibility with the vehicle to be operated, it is necessary that the ELE be prepared before each launching. This preparation consists of refurbishing the ground facilities and equipment and carrying out any modifications to them.

The ground equipment for operating the payload, particularly that for intercepting or controlling the payload's hazardous circuits or systems, has to be installed at the ELE.

The ground equipment for payload checkout may be installed either inside or outside the ELE.

All payload-associated ground equipment used for preparing the payload on the launch vehicle or for launch has to be in a working state as soon as the payload (prototype or flight unit) arrives at the ELE.

7.3.2 Individual Preparation of Stages and Payload

On arrival in Guiana, the vehicle's stages and their equipment are delivered to the Assembly Zone where they are unpacked and inspected in accordance with the specific inspection procedures for each item. Individual preparation by the stage teams comprises re-assembly of equipment dismantled for transport, checks and adjustments in the Assembly Zone (on the launch pad for the 1st stage) and ends with transfer to the launch pad.

Preparation of the upper stages (2nd, 3rd and 4th stages) is completed by the issue for each of them of a Hardware Inspection and Clearance Certificate B certifying that the stage is ready for erection. This Certificate is signed by the appropriate stage sponsor once preparation of his stage is completed.

Preparation of the 1st stage is completed by the stage sponsor's signing of Hardware Inspection and Clearance Certificate C. Issue of the Certificate authorises preparation of the ground equipment and various 1st stage systems whose joint operation leads to the static firing. All day-to-day activities connected with the preparation and conduct of the static firing are defined and timed in documents called Daily Plans which refer to trials procedures for the actual execution of operations.

Individual preparation of the payload is carried out at the CSG Technical Centre.

The nature and duration of operations carried out during this phase depend on the characteristics and complexity of the payload.

Preparation is carried out in accordance with procedures to be defined by the payload user.

The programme is to be defined by the customer and submitted to ELDO seven weeks before the launch. It should give in particular details of :

- radio transmission periods
- hazardous operations.

ELDO is responsible prior to and during the launch for :

- coordinating any satellite transmissions with the CSG programmes
- respecting safety and security regulations
- coordinating payload preparation with that of the launch vehicle.

7.3.3 Erection of Vehicle and Payload

The vehicle erection phase mainly comprises the operations of erection and assembly of the upper stages and payload upon the 1st stage. It also includes the interface checking operations during erection. Supply of the container used for transporting the satellite between the Preparation Building and the ELE (some 10 km) is the responsibility of the satellite user.

The vehicle and payload erection operations are directed by the ELDO Operations Officer. They are covered by standard procedures.

7.3.4 Overall Vehicle Checkout

The purpose of the overall vehicle checkout phase is to ensure by means of appropriate tests and checks that the vehicle configuration complies with the specifications contained in the Vehicle and Site Design Schedule Register and is therefore in a state to proceed to launch preparation. In this phase the working of all vehicle systems is checked, in particular for the following functional systems and assemblies :

- electronics assembly - radio compatibility
- flight safety
- attitude control and guidance
- ground and flight sequence

The overall vehicle checkout phase is completed by signature of Hardware Inspection and Clearance Certificate D certifying that the vehicle complies with the specifications contained in the Vehicle and Site Design Schedule Register.

A prototype payload may be used for these checks. It must be strictly identical to the flight unit :

- mechanically
- radio-electrically
- in respect of hazardous systems.

7.3.5 Launch Preparation (Countdown)

The purpose of the operations performed at ELE and CSG during this phase is to bring the vehicle, the payload and the ground equipment to the PERT status for commencing the automatic launch sequence.

They consist mainly in propellant loading of the vehicle stages and possibly an apogee motor, mounting of various pieces of equipment and of a metering and checking unit.

Final arming of the hazardous circuits (replacement of safety plugs by flight plugs) takes place during this period.

During this period a reporting network provides continual monitoring of the equipment status of vehicle, payload and ground systems.

7.3.6 Automatic Sequence

All operations taking place during the last five minutes before launch and those concerning the actual launching are carried out entirely automatically.

The only possibilities of manual intervention during the automatic sequence are :

- sequence "stop action" which may be automatic but which may also be controlled by the Operations Officer, the Safety Officer, the Stage Sponsors and certain other operators;
- certain safety commands.

7.3.7 ELE Revalidation

The ELE revalidation operations consist in refurbishing ground equipment damaged by the vehicle launching and removing payload equipment no longer required.

7.4 Payload Aspects

Although subject to change as a result of experience with the non-flight and early operational vehicles, it is believed that the launch schedule for ELDO vehicles will follow the broad outlines of sequence and time scale given below.

7.4.1 Payload Assembly Building

L-50	Receipt and Inspection Component Installation
L-49	Power Systems Checkout
L-48	Power Systems Checkout
L-47	Power Systems Checkout
L-46	Telemetry Systems Checkout
L-45	Weekend
L-44	
L-43	Telemetry Systems Checkout (continued)
L-42	Telemetry Systems Checkout
L-41	Overall Electrical Checkout
L-40	Overall Electrical Checkout
L-39	Overall Electrical Checkout
L-38	Weekend
L-37	
L-36	Overall Electrical Checkout (continued)
L-35	Overall Electrical Checkout
L-34	Preparation for Transfer to Launcher Umbilical Checkout

Note : The above preparation phase of the payload allows 13 working days and may need to be adjusted if a prototype unit is to be used in addition to the flight unit.

7.4.2 Launcher

L-33 Erection : time allowed - 6 hours.

L-32 Test umbilical connection, electrical checkout and overall vehicle bonding check. Full day activity. Electrical checks by RF and landline links. Bonding checks require 2 hours.

L-31
Weekend
L-30

L-29 Electrical checkout, overall vehicle bonding check, and test umbilical disconnection. As for L-32.

L-28 Flight umbilical tests and fairing erection. Erection of the fairings is expected to take 5 hours, and the payload umbilical tests, 4 hours. The umbilical should be installed, checked out, and prepared for the release tests on L-26.

L-27 Fairings to be fitted prior to commencing L-26.

L-26 Umbilical release tests. This is an all day test involving all stages. Umbilicals are ejected under sequencer control and their ejection trajectories and capture recorded on film for later analysis. Fairings removed at the end of these tests. Fairings fitted prior to commencing L-22.

L-24
Weekend
L-23

L-22
L-21 Overall free-standing and RF compatibility tests. This is an all day test involving all stages. RF systems in each stage are activated in a specific sequence while checks are made of any RF interference detected between systems on site or remote. The performance of RF systems with the range transmitters is checked. This is the first opportunity for the vehicle to be subjected to free-standing tests with RF systems active and can continue well into the night or be continued the following day (the tower is returned to the vehicle in the latter case). Alignment checks of the multistage vehicle are conducted during the period the tower is away from the vehicle. This can be up to 8 hours. There is limited access to the vehicle area while the tower is away, in order to minimise interference to RF patterns.

L-19 Integrated sequence and separation tests. This test is of several hours duration and involves all stages. Sequence tests of vehicle systems under simulated pre- and post-launch conditions are conducted. This is the first opportunity to check the multistage vehicle under fully representative electrical conditions.

L-17
Weekend
L-16

L-15 Integrated sequence tests. Dependent on progress on L-19, this continuation test may be relatively short. However, a 6 hour period is planned.

L-14 Certification. No planned work is scheduled for this day, which is devoted to final sign-off of the vehicle and site systems prior to entering the countdown phase. Explosive fitting has been under way for 2 days. Fairings to be installed prior to commencing L-13.

L-13 Range/payload RF checks. RF checks with the Range using the tower aerial repeaters. Note that this is permissible only after the payload or prototype has been cleared as satisfactory as a result of the RF interference tests on L-22. Kerosene is loaded into the 1st stage shortly after these checks and access to the vehicle for the remainder of the phase is restricted to essential work under controlled conditions as a result of the RF interference tests on L-22.

L-12 Upper stage propellant loading occupies all of this day. Vehicle propellant tank life committed.

L-11 As for L-12.

L-10 Systems pre-launch abort checkout. A one hour period is allocated for final payload checks. Vehicle preparation is well advanced with tower removal scheduled early the following day. Manual arming may be scheduled early the following day.

L-9 Launch abort (see Annex 3 for example of work planned in past launches for this day. The launch day work is essentially the same prior to launch).

- 7 hours : tower removal preparation commences
- 6 hours : tower removal. Stage 3 pressurisation tank life committed
- 1 hour 45 minutes : 30 minute built-in hold
- 1 hour : RF systems activation commences
- 45 minutes : payload systems ready
- 5 minutes : automatic sequence start

Note : After the abort, it will be 1½ hours to 2 hours before the tower can be returned to the vehicle.

L-8 to L-4	Systems revalidation following the launch abort which involves approximately a 7 second stage 1 run under pre-launch representative conditions. The abort is intended to provide stage 1 engine performance data, and to rehearse the teams and systems prior to the launch countdown. Assessment of results obtained during the abort countdown is conducted and preparations are undertaken for the launch countdown. Subject to a prototype payload being available, at the same certified build standard as the flight unit, this prototype may be used during all integrated tests up to and including the launch abort with the flight unit being substituted during the period L-8 to L-4.
L-3 L-2	Weekend
L-1	Systems pre-launch checkout.
L-D	Launch

Note : In the case of an abort during the launch countdown, it will be $1\frac{1}{2}$ to 2 hours before the tower can be returned to the vehicle. A repeat launch attempt will not be possible in under 16 working hours.

7.5 Control of Personnel Admittance and Movements

Admittance to BEC facilities is permanently restricted and controlled. Special provisions are in force during the operation phase and hazardous operations.

Movements of personnel on the ELE are also restricted during hazardous operations and the launch sequence.

The practical arrangements adopted to ensure control of personnel admittance and movements are described in a special regulation issued by ELDO Guiana.

The purpose of this paragraph is to set out the general principles applied for restricting personnel admittance and movements at ELE during vehicle preparation and launch sequence.

ELE is divided into 3 zones (see Fig. 7.4.6) :

- Zone A = zone covering the immediate vicinity of the launch platform
- Zone B = zone beyond which an explosion of the vehicle cannot endanger personnel
- Zone C = unprotected precarious zone.

Access to these 3 zones is normally authorised for badge wearers.

During launch preparation, access to certain facilities is additionally restricted to essential staff whose names figure on nominal lists. To facilitate controls, numbered discs or coloured patches may be issued to authorised staff. These patches will be of three colours : white, green and red. Personnel wearing the appropriate patch are allowed to move around in the zone to which the colour applies at that particular time.

The table below gives the zone colours for the various phases.

Sequence	Admittance to Zone A	Admittance to Zone B	Admittance to Zone C
Erection	white green red	white green red	free
Checkout	white green red	white green red	free

Sequence	Admittance to Zone A	Admittance to Zone B	Admittance to Zone C
Initial arming (installation of pyrotechnical equipment, etc.)	I(a)	green red	free
Fill operations	I(a)	I(b)	free
Post-fill operations	red	green red	free
Final arming (connecting) ($H-7^H$)	I(a)	I(b)	free
Lox fill ($H-4^H$)	Prohibited	I	I(c)
Final launch sequence	Prohibited	I	I(c)

Key :

I = prohibited outside launch centre

I(a) = except pyrotechnics or propellant operators and safety personnel

I(b) = except emergency team

I(c) = except essential staff : emergency team, meteorology, skyscreen telelimiters, Cotal-Adour radar, Diane, possibly optical camera operators, who are required to wear a mask.

Notes :

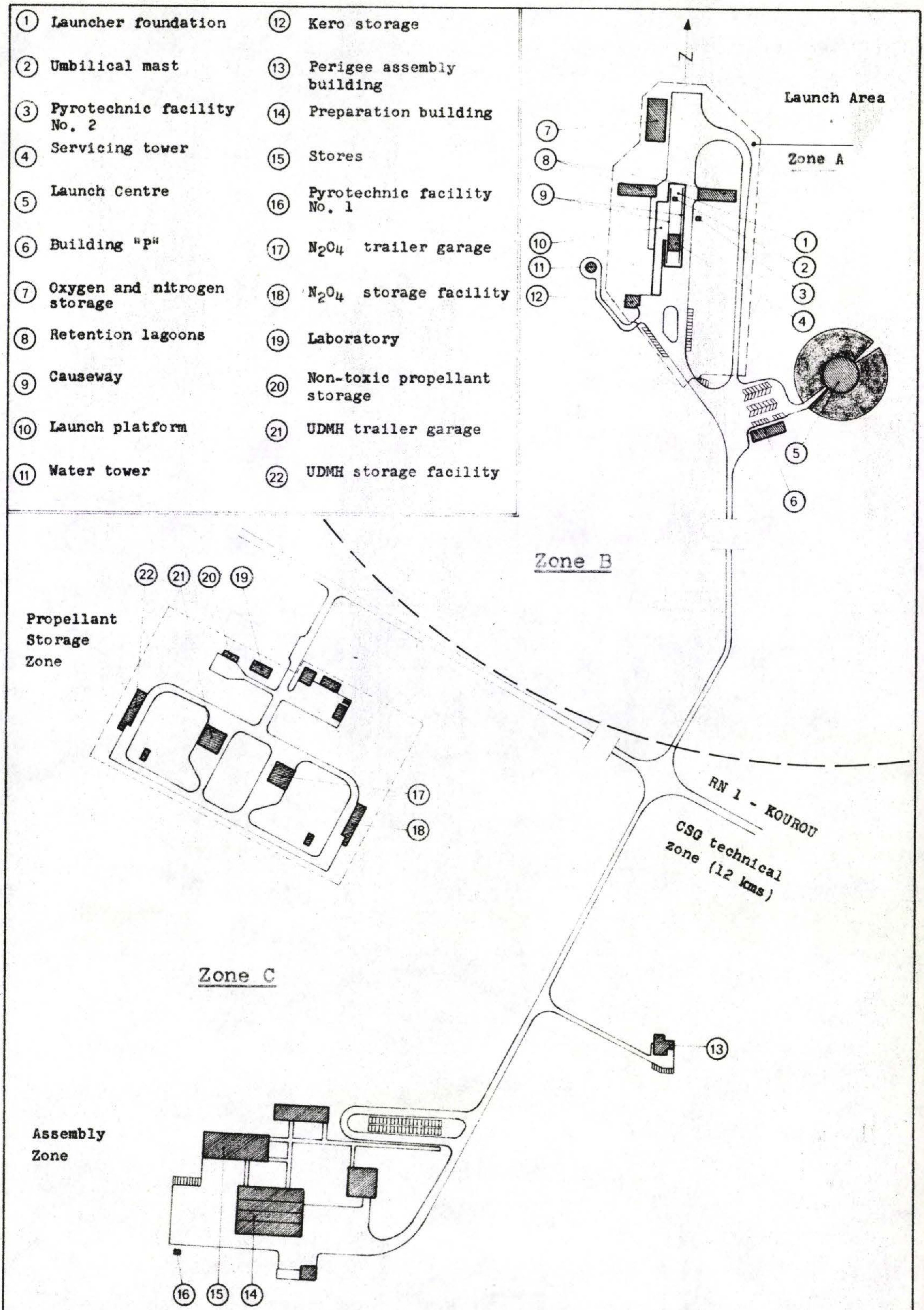
1. National Highway RN.1 is closed prior to a launching. The time of closure is stated in the Launch Request. Closure prohibits, in particular, traffic between the Technical Centre and the Diane-Iris Station.

2. Restrictions on movements within these zones or on admittance to certain facilities may be imposed due to certain non-hazardous operations (transmission, radio-electric compatibility). These restrictions are stated in the Launch Request.

7.6 Restrictions on Electrical Connection of the Payload

The payload may not be electrically connected during hazardous operations :

- initial arming
- propellant loading
- final arming.



① Launcher foundation
② Umbilical mast
③ Pyrotechnic facility No. 2
④ Servicing tower
⑤ Launch Centre
⑥ Building "P"
⑦ Oxygen and nitrogen storage
⑧ Retention lagoons
⑨ Causeway
⑩ Launch platform
⑪ Water tower
⑫ Kero storage
⑬ Perigee assembly building
⑭ Preparation building
⑮ Stores
⑯ Pyrotechnic facility No. 1
⑰ N_2O_4 trailer garage
⑱ N_2O_4 storage facility
⑲ Laboratory
⑳ Non-toxic propellant storage
㉑ UDMH trailer garage
㉒ UDMH storage facility

Dessiné par:
Vérifié par:

Titre:
Restricted Entry Zones during opérations "EUROPA"

Page: AL. 0
Figure: 7.1

OVERALL PREPARATION PLAN FOR AN EUROPA LAUNCH

1. OBJECT

The detailed test plan, type 3 (DTP) describes the test programme for the multistage reference vehicle (MSRV) at E.L.S commencing with the initial preparation of the stages in the assembly building and culminating in a static firing of stage 1 with the upper stages erected.
Additionally decontamination and diserection of the vehicle are covered.

This programme is given only for information; indeed the preparation of the flight vehicles will be carried out according to a shorter programme.

2. STRUCTURE OF THE TEST PROGRAMME, DEFINITION OF WORKING PHASES

The test programme is divided into working phases, the number of which is higher for the M.S.R.V. programme than it will be for a normal preparation for launch. These working phases are defined below.

Individual preparation of stages in assembly building (H.A.)

1A Stage 1 in H.A. and erection

2A Stage 2 in H.A.

3A Stage 3 in H.A. and erection of lower section

4A Stage 4 in H.A. and in perigee assembly building (B.A.P.)

5A stage 5 (capsule) in H.A.

Preparation of stages after erection, practically independent of each other

1B Stage 1 on launcher, including multiple propellant transfer

2B Stage 2, erection and checkout after erection

(Note: Propellant transfer exercise with calibration tanks already carried out prior to commencement of the D.T.P.)

3B Stage 3, erection of main section and checkout after erection

3C Stage 3, propellant transfer exercise to be carried out after phase (see below)

Common working phases

9 A Erection and checkout of stages 4 and 5;
preparation and erection of fairings (considered as "stage 6");
final activities of lower stages prior to phase 9B

9B Overall test phase, including E.M.U. type tests

9C Filling of vehicle, static firing, decontamination and diserection of vehicle.

.../...

3. LAYOUT OF THE D.T.P.

Bar chart summary of the programme, scheduling the working phases relating to calendar dates and "S minus or S plus days", the days before and after the static firing (the static firing day being "S").

The working days of each work phase are identified by minus numbers, e.g. "-2" of phase 1A means that this is the second day to last working day of phase 1A.

The summary indicates additionally where significant support from E.L.S. equipe site or C.S.G. range is requires.

Detailed description of each phase

One chapter is used for each phase.
The order of the chapters within the D.T.P. corresponds to the phase numbers 1A, 1B, 2A etc..., as defined in paragraph 2 above.

Each chapter consists of:

- a logic chart displaying the sequence of activities against the working days scheduled for the phase,
- daily programmes describing on separate pages for each working day, the activities scheduled for this day.

(Note: The times to carry out activities, indicated on these pages, are preliminary estimates only.)

4. ABBREVIATIONS AND SIGNS

Summary pages

S	static firing day
├──┤	start, duration and end of working phase
┬┬┬┬┬	periods with possible restrictions on other teams activities
△	significant events, defined under "Remarks" at the bottom of the page

Other pages

B.A.P.	Perigee assembly buildings
C.L.	Launch center
D	Team "directing" an activity
H	Estimated time in hours
H.A.	Assembly building
J/D	Estimated time in days
P	Teams "participating" in the execution of an activity, directed by another team

.../...

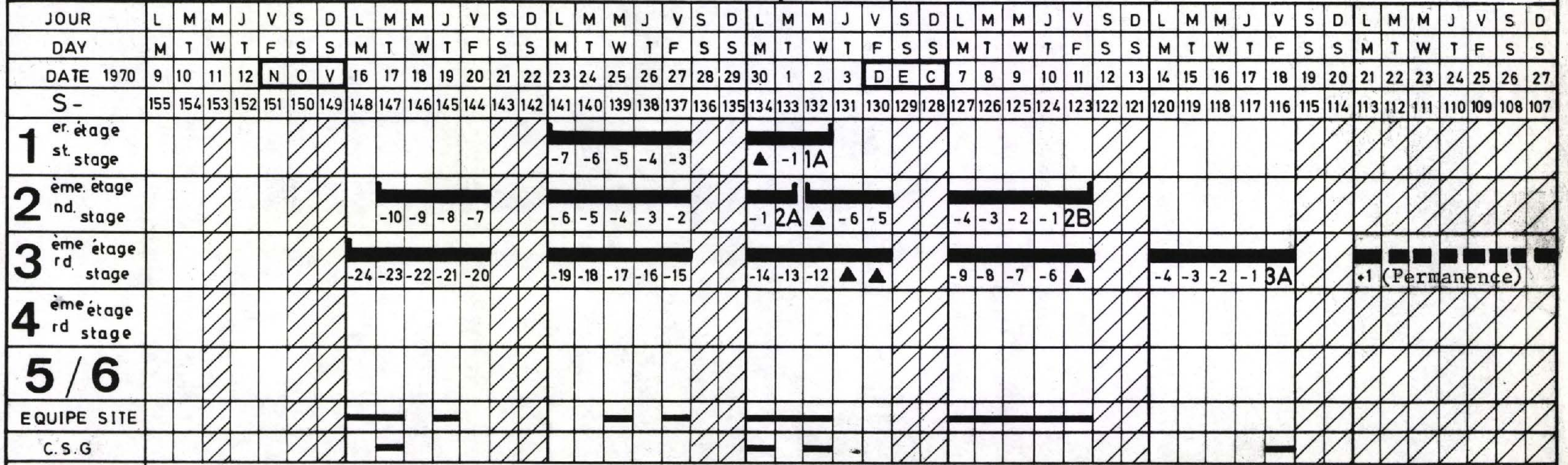
P.C.A.	Test post
S	Static firing day
T	Prefix to code number of temporary activities for M.S.R.V. only
RT	Technical Regulation

E : 6/11/70
Issued :

SOMMAIRE - SUMMARY

PA : 4
AMEND.N° : AL.0

PHASE	DESCRIPTION DE L'ACTIVITE	PHASE	DESCRIPTION OF ACTIVITY
1A	Préparation du 1er étage dans le hall d'assemblage et érection	1A	Preparation of Stage 1 in assembly building and erection
2A	Préparation du 2eme étage dans le hall d'assemblage	2A	Preparation of stage 2 in assembly building
2B	Erection et activités du 2ème étage après érection	2B	Erection and activities of stage 2 after erection
3A	Préparation du 3ème étage dans le hall d'assemblage	3A	Preparation of stage 3 in assembly building



JOUR	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D
DAY	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
DATE 1970	9	10	11	12	N	O	V	16	17	18	19	20	21	22	23	24	25	26	27	28	29
S-	155	154	153	152	151	150	149	148	147	146	145	144	143	142	141	140	139	138	137	136	135
1 er. étage st. stage															-7	-6	-5	-4	-3		
2 ème. étage nd. stage									-10	-9	-8	-7			-6	-5	-4	-3	-2		
3 ème étage rd stage								-24	-23	-22	-21	-20			-19	-18	-17	-16	-15		
4 ème étage rd stage																					
5/6																					
EQUIPE SITE																					
C.S.G																					

JOUR	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D
DAY	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
DATE 1970	30	1	2	3	D	E	C	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
S-	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112	111	110	109	108	107
1 er. étage st. stage	▲	-1	1A																									
2 ème. étage nd. stage	-1	2A	▲	-6	-5			-4	-3	-2	-1	2B																
3 ème étage rd stage	-14	-13	-12	▲	▲			-9	-8	-7	-6	▲			-4	-3	-2	-1	3A			+1 (Permanence)						
4 ème étage rd stage																												
5/6																												
EQUIPE SITE																												
C.S.G																												

Remarques
Remarks

30.11.70 - Erection étage/stage 1

2.12.70 - Erection stage/étage 2

3/4.12.70- Test Guidage/Pilotage

11.12.70 -(Erection section inférieure du 3ème
(étage -
(Erection stage 3 lower section

12.12.70 - Tir DIAMANT / Launch of DIAMANT

Vacances Noël
Christmas Holidays

E :

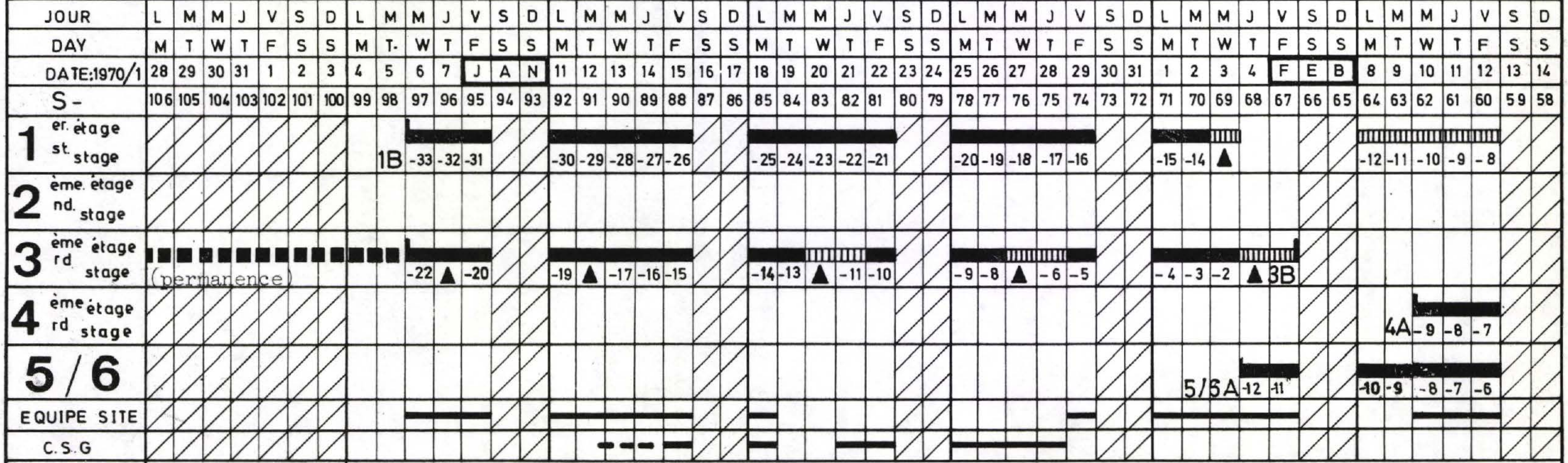
Issued : 13/11/70

SOMMAIRE - SUMMARY

PA : 5

AMEND.N° : AL.O

PHASE	DESCRIPTION DE L'ACTIVITE DESCRIPTION OF ACTIVITY	PHASE	DESCRIPTION DE L'ACTIVITE DESCRIPTION OF ACTIVITY
1B	Préparation du 1er étage après l'érection	1B	Preparation of stage 1 after erection
3B	Préparation du 3ème étage dans l'Aire de Lancement	3B	Preparation of stage 3 on Launch Pad
4A	Préparation du 4ème étage	4A	Preparation of stage 4
5/6A	Préparation de la capsule et de la coiffe	5/6A	Preparation of capsule and fairing



Remarques
Remarks

Vacances Noël
Christmas
Holidays

7.1.71 Erection étage/stage 3

12.1.71 Haute pression (3 heures)
High pressure (3 hours)

20.1.71
21.1.70
22.1.71 Essais Guid./Pilot.
Guid. + Contr.Checks

27.1.71
28.1.71 Programmeur sol
demandé/required

3.2.71 à/to 15.2.71 Programmeur sol
demandé/required

4.2.71 Haute pression
5.2.71 High pressure

FORM.N° 22

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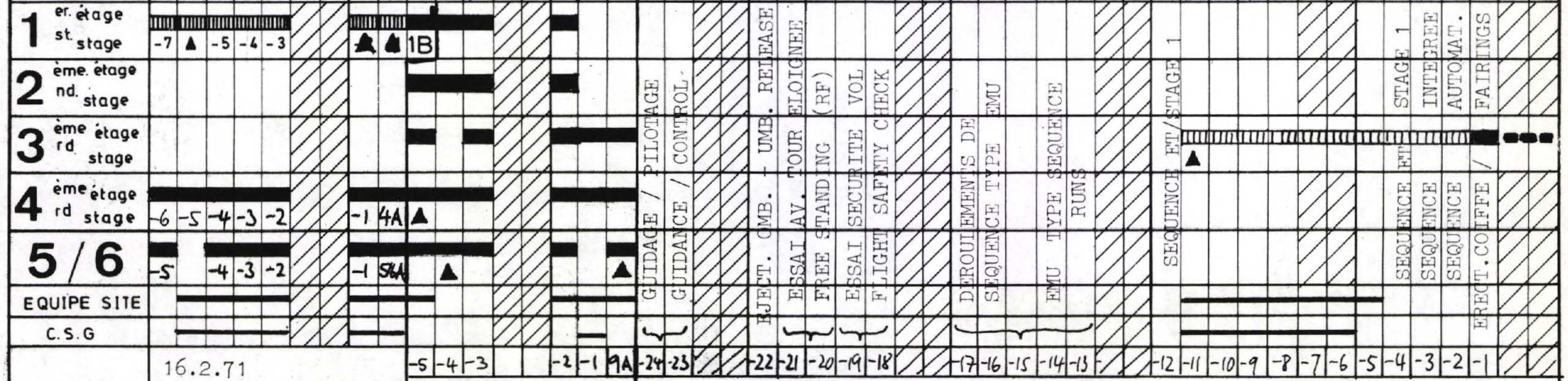
PHASE	DESCRIPTION DE L'ACTIVITE DESCRIPTION OF ACTIVITY	PHASE	DESCRIPTION DE L'ACTIVITE DESCRIPTION OF ACTIVITY
1B	Préparation du 1er étage après l'érection	1B	Preparation of stage 1 after erection
4A	Préparation du 4ème étage	4A	Preparation of stage 4
5/6A	Préparation de la capsule et de la coiffe	5/6A	Preparation of capsule and fairing
9A	Phase d'érection des étages 4,5 et coiffe	9A	Erection phase of stages 4,5 and fairings
9B	Essais intégrés et exercice de remplissage du 3ème étage	9B	Overall tests and stage 3 fuelling exercise

JOUR	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D	L	M	M	J	V	S	D
DAY	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
DATE 1971	15	16	17	18	F	E	B	22	23	24	25	26	27	28	1	2	3	4	M	A	R	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	A	P	R
S -	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9



Phase 9A

Phase 9B

Remarques
Remarks

16.2.71 Remplissage 1er Et.
Stage 1 fuelling
22/23.2.71 Tour éloignée
Tower removed

24.2.71 Erection Etage/Stage 4
25.2.71 Erection Etage/Stage 5

3.3.71 Erection Coiffe/Fairings
23.3.71 Remplissage 3ème Etage
Fuelling Stage 3

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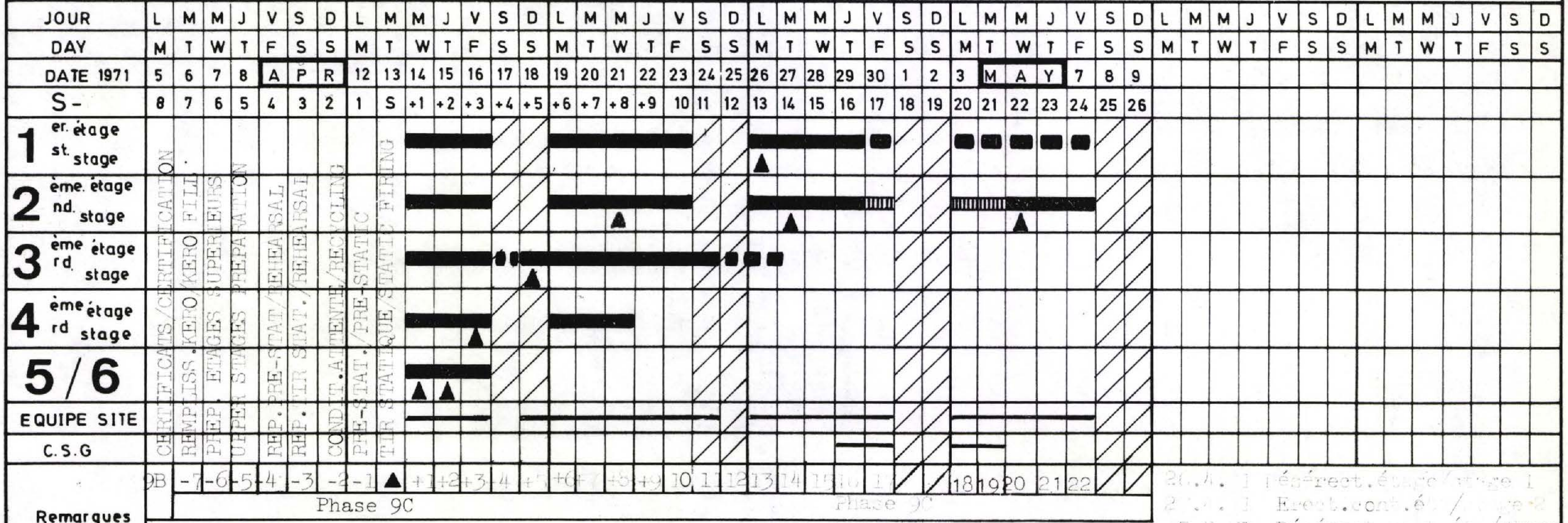
PHASE	DESCRIPTION DE L'ACTIVITE DESCRIPTION OF ACTIVITY	PHASE	DESCRIPTION DE L'ACTIVITE DESCRIPTION OF ACTIVITY
9B	Essais intégrés et exercice de remplissage 3ème étage	9B	Overall tests and stage 3 fuelling exercice
9C	Activités avant, pendant et après le tir statique	9C	Activities before, during and after the static firing



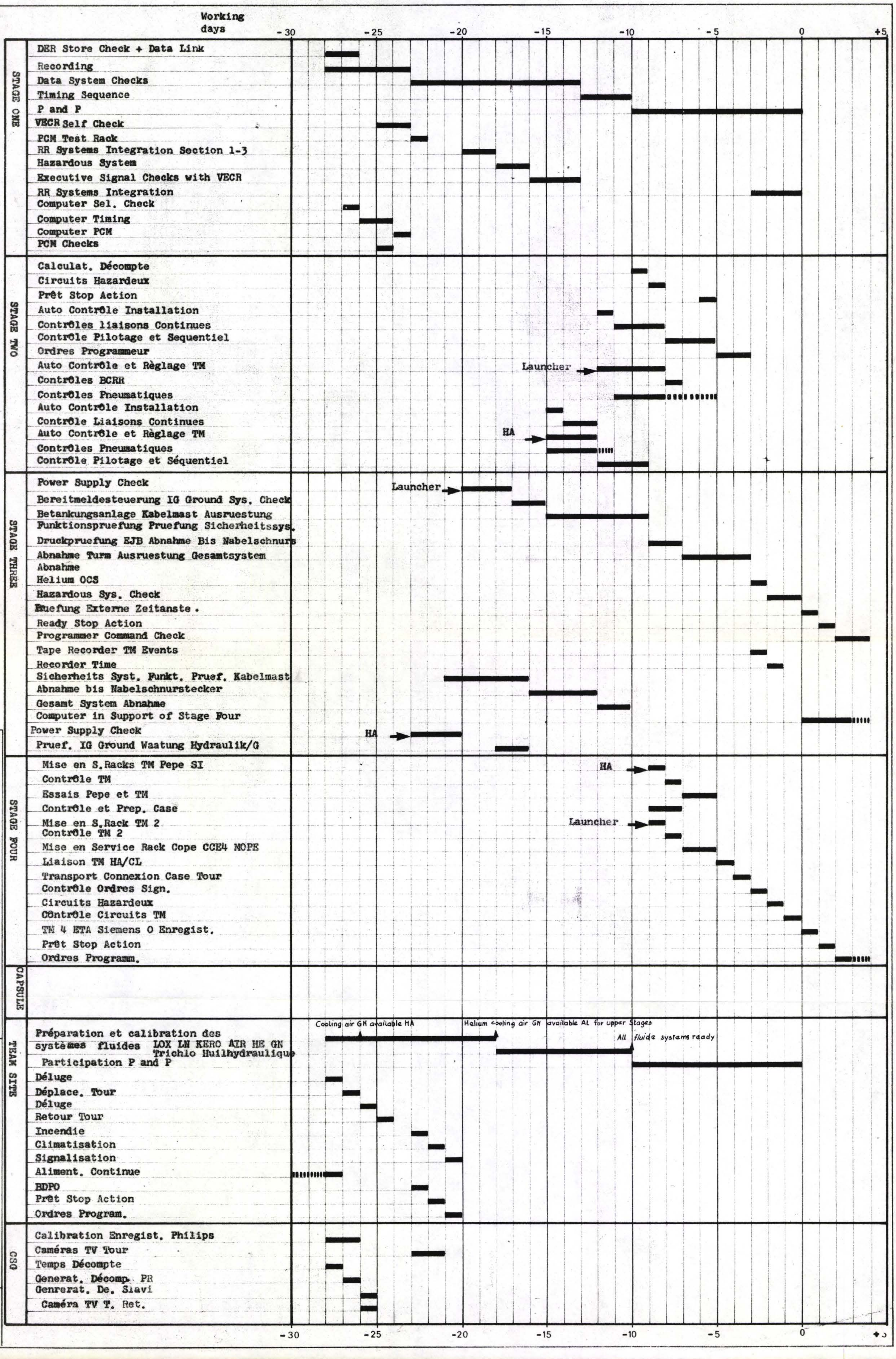
Remarques
Remarks

13.4.71 Tir statique - Static firing
14.4.71 Déséreection coiffe-fairings
15.4.71 " étage/stage 5

16.4.71 Déséreection étage/stage4
18.4.71 " " " 3
21.4.71 " " " 2

20.4.71 Désérect.étage/stage 1
[illegible] Erect.cont.ét./stage 2
5.5.71 Désérect.cont.ét./stage 2

SITE REVALIDATION F 11



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SITE REVALIDATION F 11

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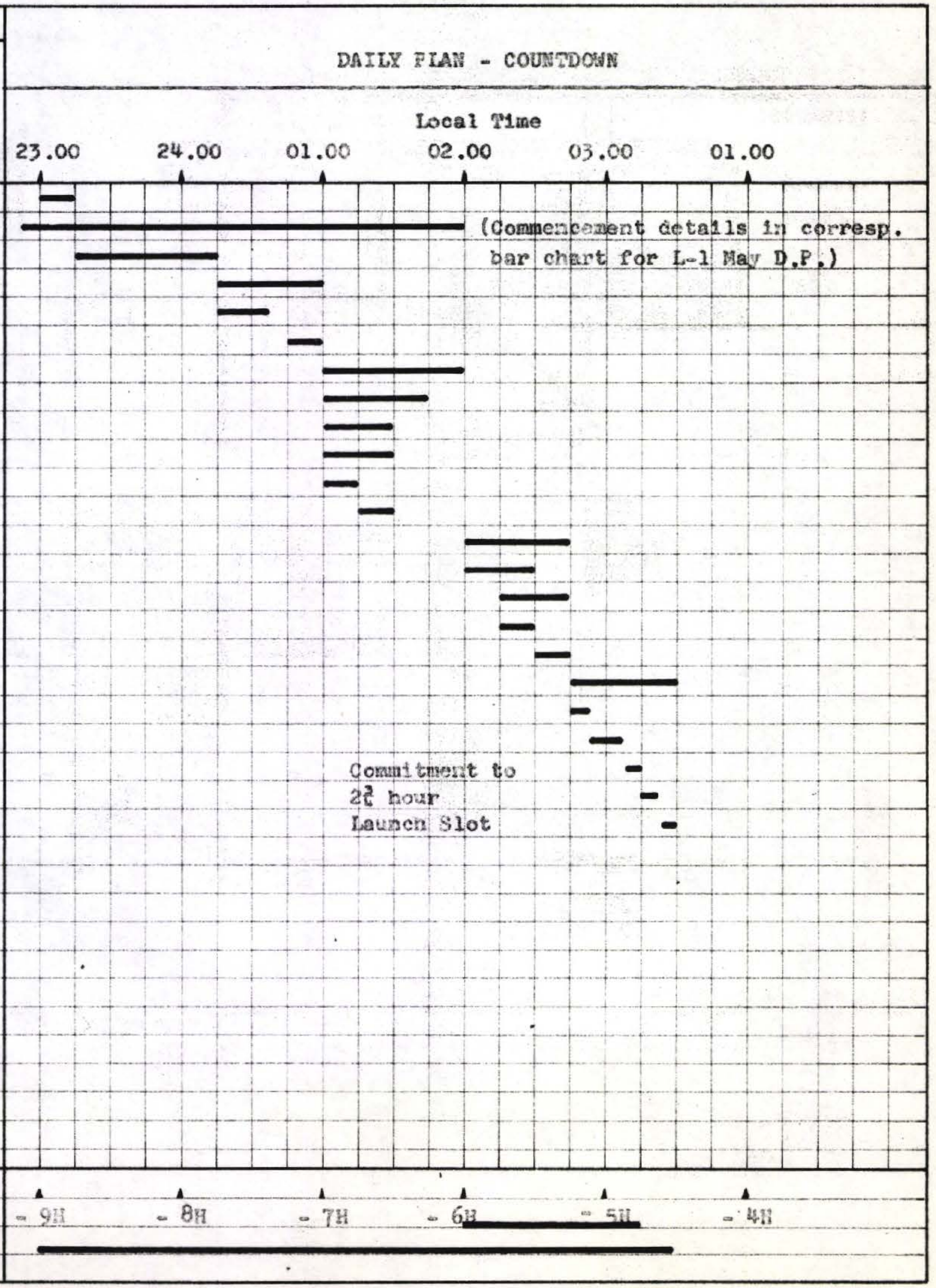
Figure:
ANNEX -2

DAILY PLAN - COUNTDOWN

Dessiné par:
Vérifié par:

C = Control P = Participation

Task Number	TRIALS ACTIVITY	Overall	A.N.T.	Stage 1	Stage 2	Stage 3	Stage 4	R.A.
	Team and Planels Check	C	P			P		P
09820	Set up Platform (continued)					C		
09800	Pressurise Helium Bottle		P			C		
09750	Umbilical Arming		P		C			
09665	Set Down Helium System		C			P		
09664	Team Check	C		P			P	
09656	Final Prep. for Tower Move		C					
09654	Prep. for Lox Precool		C					
09640	Remove Tensioning Ring		P	C				
09626	Arm Sep Bolts & B.U. Units			P				C
09624	Remove Probe Jack Covers			C				
09620	Check GN Pressures		P	C				
08270	Move Tower to Park Posn.		C	P				P
07815	WREBUS Ground cont. Check							C
07800	Progressively Clear Area							C
07760	Arm Lox/LN Valves			P				C
07510	Check Space Ref. Signals			C				
07440	Precool Lox System		C	P				
07420	Open Rolling Platforms			C				P
07340	Check Transponders				C			P
07240	WREBUS Checks	P		P	P			C
07123	Pressurise Bottle			C				
07110	Pressurise LN Storage Tank			C				



CONTROL HOLD POINTS
TIME TO LAUNCH
RANGE SYSTEMS REQUIRED
RESTRICTIVE ACTIVITY PERIODS

Titre:

Page: 1
Figure:

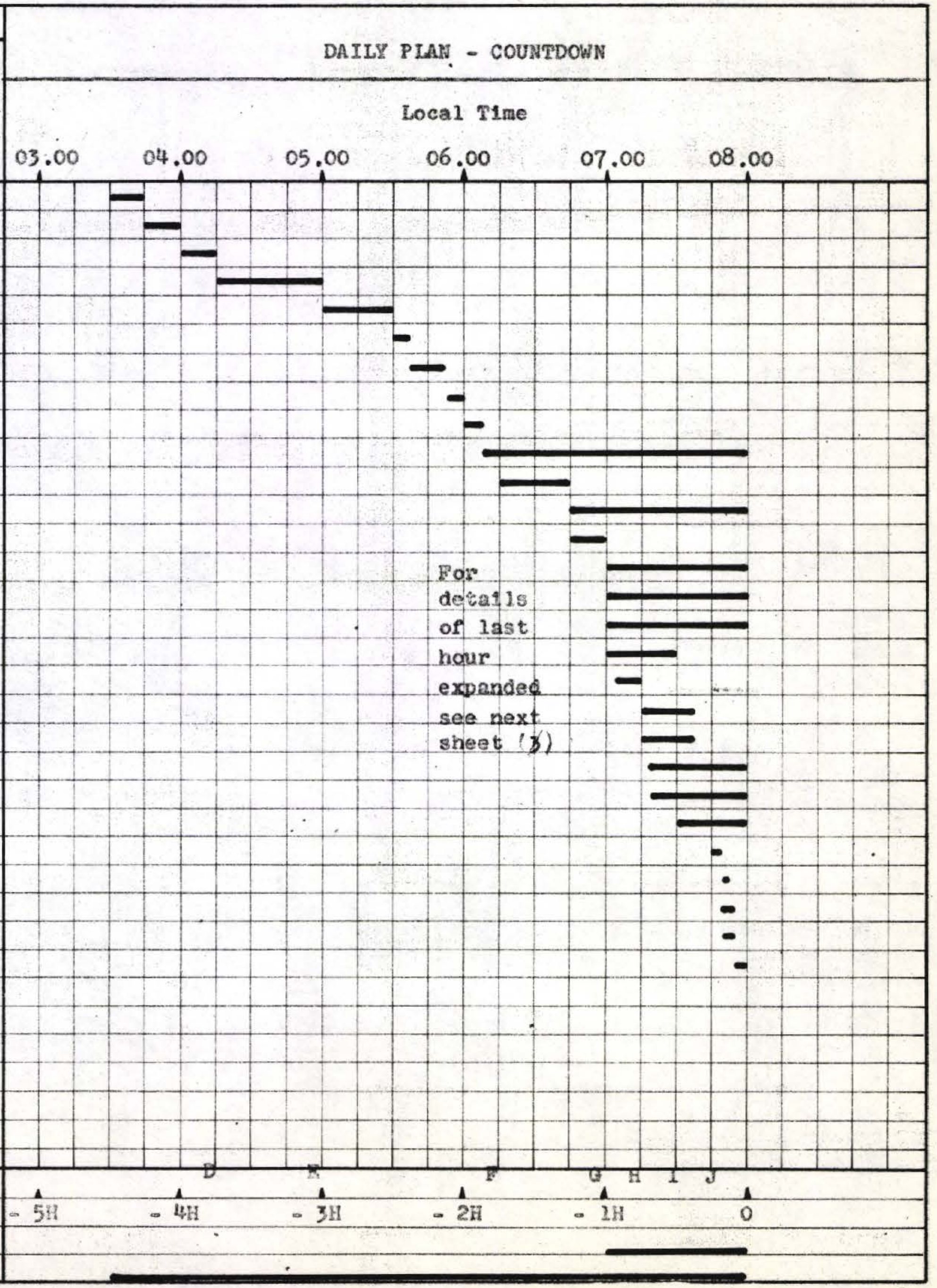
ANNEX 3 A.L.O.

Dessiné par:
Vérifié par:

C = Control P = Participation

Task Number	TRIALS ACTIVITY	TEAM Overall	A.N.T.	Stage 1	Stage 2	Stage 3	Stage 4	R.A.
07030	Prepare for LOX Transfer	C		P				P
06950	Test Post Arming							C
06870	Check Lox Site Tank Press.			C				
06705	Commence LOX Transfer	C		P				
06150	LOX Transfer Pumping	C		P				
06097	Personnel to LOX Area		P					C
06096	Depress. No. 2 LOX S/Tank			C				
06091	C/O to No. 1 LOX S/Tank			C				
06090	Personnel to EC.6		P					C
06089	LOX Topping.			C				
	Countdown Phasing							
05965	Satellite Power on	C					P	
05960	T/L & OTL Briefing	C	P	P	P	P	P	P
05840	Transponders on	C			P			P
05790	Ajax Tele ON				C			P
05710	LN Transfer			C				
04970	Check Redline Selectors			C				
04940	Check GN Pressures			C				
04854	Pressurise Vehicle Tanks	C			P			
04825	Trim Kero Level			C				
04730	465 Tele ON	C		P				
04650	Stage 3 Tele ON	C				P		P
04540	Autopilot ON	C		P				
04293	Raise Lox Storage Tank Press.			C				
04240	Check System Ready	C						
94230	Patches IN	P						C
03920	Synchronisation Check	P						C
03680	5 Minute Sequence	P		P	P	P	P	C

CONTROL HOLD POINTS
TIME TO LAUNCH
RANGE SYSTEMS REQUIRED
RESTRICTIVE ACTIVITY PERIODS



For details of last hour expanded see next sheet (3)

Titre:

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Figure:

ANNEX 3 A.L.O

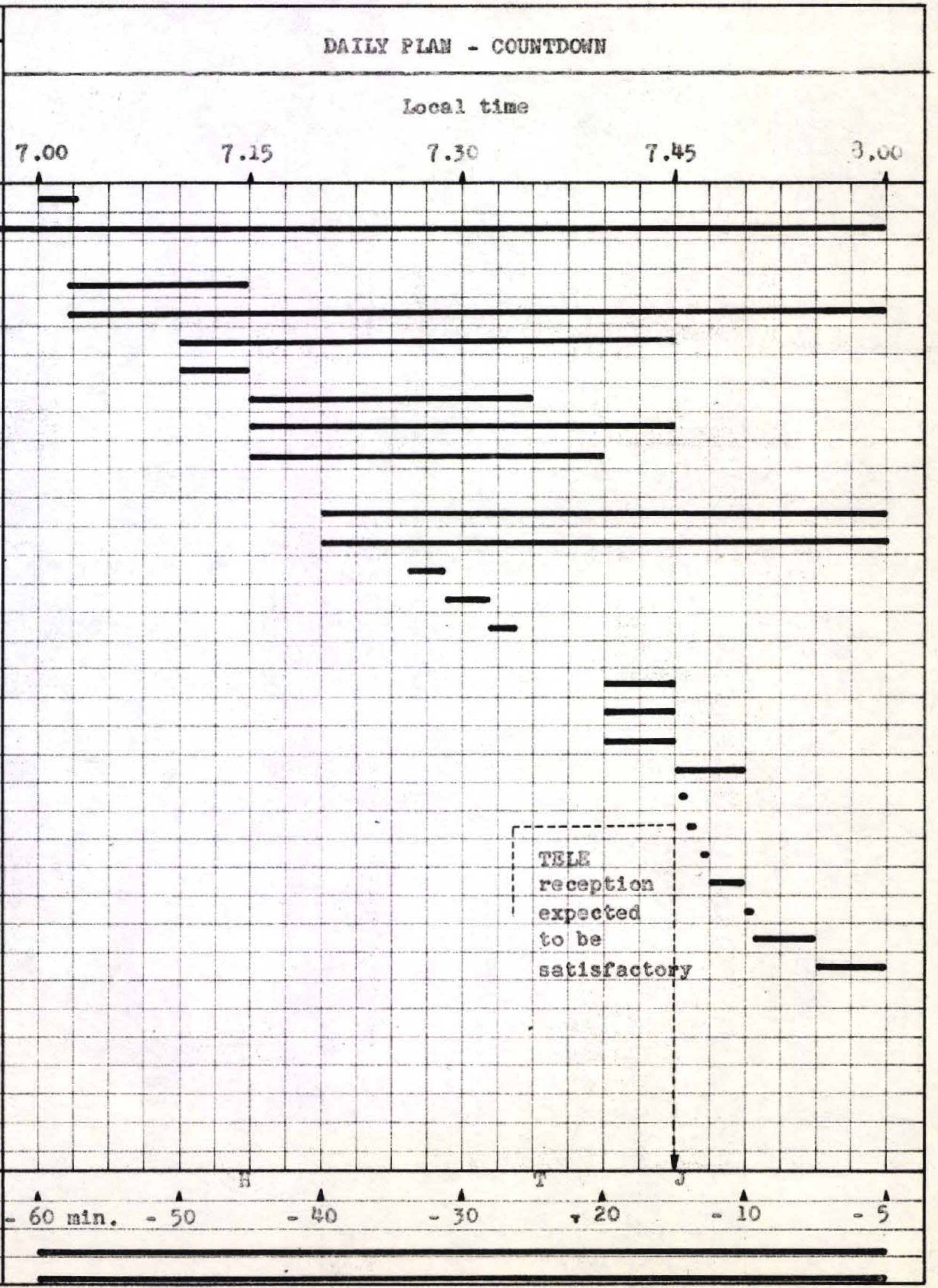
Dessiné par:
Vérifié par:

C = Control   P = Participation

Task Number	TRIALS ACTIVITY	Overall	A.M.T.	Stage 1	Stage 2	Stage 3	Stage 4	R.A.
05870	Interrogate Transponders	C						P
05968	450 Tele ON	C		P				
05780	AJAX- A/P On. Checkout				C			
05710	LN Transfer.	C		P				
04970	Check Redline Selectors			C				
04960	Emerg. GN ON Chk. Press.			C				
04856	Fuel Tank Press.	C			P			
04830	Clear Personnel							C
04825	Trim Kero Level			C				
04730	465 TELE ON	C		P				
04680	PTI TELE ON. Checkout	C				P		P
04620	Panels Check	C		P				
04560	Set Up Safety CE	C		P				
04520	Start Hydraulic Trolley			C				
04274	ST. 1. Systems Ready			C				
04410	ST. 3. Systems Ready					C		
04406	ST. 4. Systems Ready						C	
04310	ST. 2. Systems Ready				C			
04293	Raise Lox Storage Press.			C				
04280	Diaphragm Diff. Prot. Off.			C				
04270	D.T.G. Reset. Auto Hold	C						
04240	O.S.O. Live Patch In.	C						
04230	Range E Patches In.	C						P
04050	Check Kero Temp.			C				
03920	Synch. & S/A Checks	C						P
03680	Auto Sequence	P						C

Titre:

CONTROL HOLD POINTS
TIME TO LAUNCH
RANGE SYSTEMS REQUIRED
RESTRICTIVE ACTIVITY PERIODS



TELE reception expected to be satisfactory

Page: 3
Figure:

ANNEX 3 A.L.O.

8. HAZARDOUS SYSTEMS

8.1 Introduction

8.2 Definitions

8.3 Design requirements

8.4 Manufacturing requirements for the hazardous electrical circuits

8.5 Pressurised systems

8.6 Propellants

8.7 Radioactive and toxic materials

8.8 Submission and approval procedures for the hazardous systems

CHAPTER 8 - HAZARDOUS SYSTEMS

8.1 Introduction

In the following, some information will be given about the Safety Regulations which have to be followed for the design, manufacture, maintenance and approval of hazardous systems.

More details, however, can be found in the "Règlement de Sauvegarde" and "Règlement Technique RT6, Sauvegarde en Guyane", published by CNES-CSG and ELDO respectively.

8.2 Definitions

8.2.1 Hazardous system

This includes all systems which involve the use of hazardous components such as explosives and/or propellants, inflammable and/or toxic chemical products, high pressure gases and radioactive products.

8.2.2 Hazardous electrical circuit (HEC) (*)

This consists of all circuits connected to the hazardous devices for their operation and/or monitoring. These circuits include the primary hazardous electrical circuit (PHEC) and the secondary hazardous electrical circuit (SHEC).

8.2.3 Primary hazardous electrical circuit (PHEC) (*)

This includes all circuits which directly connect the hazardous components to their power supply for ignition (e.g. the circuit made up of the battery contact of the ignition relay and the explosive bolt is considered a PHEC).

(*) British and French equivalents used in the French Guiana Safety System are given below :

HEC = Circuit Electrique Dangereux = CED

PHEC = Circuit Electrique Dangereux Primaire = CEDP

SHEC = Circuit Electrique Dangereux Secondaire= CEDS

8.2.4 Secondary hazardous electrical circuit (SHEC) (x)

This includes all circuits which operate and/or monitor the status of the relative PHEC circuit(s).

8.2.5 Interception

Interception is an interruption in the continuity of the PHECs. This interruption will not be operated without the agreement of the CSG Safety Officer.

8.2.6 Interception console

The interception console is the control desk from where the PHEC status can be operated and monitored.

8.2.7 Interception devices

Interception devices are the devices which control the continuity of the PHECs.

The firing switch is the switching device which at the prescribed time closes the circuit between the power supply and the hazardous component.

8.3 Design Requirements

8.3.1 General requirements

Each PHEC must include at least two independent interceptions, one located as near the hazardous device as is praticable, and the other near the power supply. These have the following functions :

a) Interception No. 1 (near the hazardous device). To provide a physical break which can be used for testing in both directions of the circuit. It is kept open during the preparation phase of the vehicle and is closed during the countdown following a prescribed procedure.

b) Interception No. 2 (near the power supply). To provide an electrically operated break which only closes when a demand for the system operation is initiated. Other interceptions may be incorporated at the request of the Range Authority to provide them with an overriding control.

The PHEC circuits must be designed to be operated only by either one person or by an order, and so that inadvertent operation can only occur if either two wrong operations are carried out or if two simultaneous but unrelated faults are present.

8.3.2 Interceptions

a) Requirements for Interception No. 1

This interception is to be achieved by the use of armed and safe plugs fitted to an arming socket. The indication that the circuit is not intercepted (is armed) will be given by the form of the plug inserted. The form of the arming plug will be circular, painted with black and yellow stripes.

Around the socket on the vehicle where the arming plug is inserted, a circular area, having a diameter of at least double that of the plug, delimited by a white circle, will be painted exactly like the plug and when the plug is in place the stripes will not show any discontinuity. In case the socket cannot be marked as indicated, an arrow can be used instead, painted in the same way with the head as near as possible to the socket which must be identified.

When the circuit is not armed, the operational plug must be replaced by a safe plug which, once in place, prevents any accidental short circuit between the pins of the socket.

When the safe plug is in place, the circuit between the explosive device and the plug must be in short circuit to avoid the inadvertent initiation of the charges due to electrostatic charges.

This requirement must also be respected in designing the control circuits when only low energy is required for the switching (e.g. thyristors, etc.).

The form of the safe plug will be triangular, uniformly painted in red.

A red mark must appear outside the vehicle at the level of the interception plug.

If the range user wishes to have a remote control on this interception, he has to negotiate the design and the relevant procedure with the Range Safety Officer.

b) Requirements for Interception No. 2

This interception, near the power supply, will be controlled by the range user from his operating console or in flight by the in-flight sequencer. In both cases, two requirements are mandatory for the control circuit :

./..

i) This interception must be operated only with previous authorisation from the CSG Safety Officer. As a consequence, the circuit must include an authorisation contact operated from the interception console.

ii) Power failure on the launch pad must cause the interception to fail safe.

8.3.3 Power supplies

The power supplies which have to initiate the explosive components must be separated from the others (namely those supplying the amplifiers, relays, etc.), both on the ground and on board. The PHECs in particular must be floating with respect to the structure(or the frame of the rack in the case of ground equipment). To avoid dangerous devices being initiated by electrostatic charges, a high value resistor (1 Kohm ÷ 1 Mohm) will be connected between the structure and one of the poles of the circuit. However, in order to check the insulation of the circuit with respect to earth, it must be possible to disconnect this resistor.

Should a power supply be common to several PHECs, the circuit must be such that a failure in one of the circuits does not involve any malfunction in the others.

8.3.4 PHEC circuits

The dangerous components which have to be triggered by the PHECs will never be connected in parallel unless simultaneously operated. However, in this case, adequate protection must be sought by using non-inductive resistors in order that a short circuit in one branch does not affect the operation of the others.

In particular, when, in order to increase reliability, devices with double igniters each connected to a separate PHEC are used, the connection must be so designed that a short circuit in one circuit does not trigger the others.

The level of any interference signal of any source must be kept lower than 30 dB with respect to the operating level (power level for relays, voltage level for pyrotechnic devices and associated solid state switches) in order to avoid any inadvertent triggering of the circuit.

The manufacturer is required to give evidence that these specifications are fulfilled.

8.3.5 SHEC circuits

The SHEC circuits include all the circuits which serve to initiate, control and monitor the status of the PHEC circuits. The main requirement for these circuits is that, in case of loss of power on the launch pad, they are inhibited to initiate the PHECs as these circuits, consistent with requirement ii), para 8.3.2 automatically switch to a safe position.

There shall be no direct electrical connection between PHECs and SHECs and mechanical contact between PHECs and SHECs shall be such that a malfunction in them does not affect any PHEC.

The status of the interception on the PHEC circuits must be permanently monitored during the countdown sequence and in particular the following information must be displayed :

a)	Interception devices (Interception No. 2)	Intercepted (disarmed) Not intercepted (armed)
b)	Devices which are not in operation during the ground phase	Passive (disabled)

The monitoring of a few hazardous circuits can be grouped if they should operate simultaneously.

A typical example of connection of the SHEC circuits is shown in fig. 8.1. A series of "Standard Card Circuits" is available in a rack at the Test Post (PCA).

The status of the PHEC circuit is controlled from the user console by relay C which may be considered bistable for the sake of simplicity. However this control is possible only if the Safety Officer in the Range Control Centre has closed the key switch which energizes relay X/4(X1 and X2 are then closed).

Red and green lamps monitor the position of the C relay (i.e. the PHEC status) on which depends the closure of contacts C2 or C3.

A contact closed between pin 23 and pin 24 energises the relay V/2 which closes the contact V1 lighting an amber lamp which indicates the passive state of the circuit.

Contacts X4, Y2, Z2 can be utilised by the Spacecraft Agency in order to monitor the status of the circuit :

X4 closes when the PHEC operation is authorized by the Safety Officer.

Y2 closes when the PHEC is armed

Z2 closes when the PHEC is disarmed.

When a repeater relay is placed between the intercept devices and the interception console, the indication of its status must also be taken into consideration as shown in Fig. 8.2.

8.3.6 Cross talk and shielding

In order to avoid as far as possible any risk of cross talk with other circuits, separate plugs, wiring and cable looms will be provided for different hazardous circuits.

All PHECs must be continuously screened throughout their length and must be connected to earth only at one point, i.e. as near the hazardous device as is practicable. The shielding must not be broken by any intercept throughout any connector in the circuit.

The shield must also be extended in the connectors.

8.4 Manufacturing Requirements for the Hazardous Electrical Circuits

8.4.1 Components

The components used in the hazardous systems must have a high reliability standard. In particular, either the specifications already established by the manufacturers and approved by ELDO or the MIL, DEF CCTU, KEBR specifications must be followed.

All components which are installed in the flight units must have undergone a tropicalisation process.

Although details of this process are left to the discretion of the manufacturer, a minimum time of 168 H must be adopted for the endurance runs. At the time, the manufacturer will provide ELDO with a description of the tropicalisation processes and the results obtained.

Components will be chosen that can in no case be overloaded even for a short period of time.

8.4.2 Qualification

The components must be accepted according to the procedures of qualification and acceptance stated in the specifications used for the choice of components (para. 8.4.1). The test levels must correspond to the environmental requirements of that part of the vehicle where the components have to be installed, as specified in Chapter 5 of this manual.

At the request of ELDO, evidence must be given by the manufacturer that the components used have successfully passed the qualification and acceptance tests.

8.4.3 Cables and wires

All cables must be adequately protected against corrosive liquids and/or gases. The shells of all the connectors must be electrically connected to the structure of the vehicle.

A particular colour of the manufacturer's choice must be used to distinguish the PHECs from the other circuits, for easy location.

Separate cable looms and connectors will be used for both PHECs and SHECs.

8.4.4 Connectors

Where a PHEC is required to pass through a connector, that connector must not be used for any circuit which is not primary hazardous. The connector size must be such that the number of unused pins is at a minimum and the conductor/pin arrangement inside the connectors must be such that even in a very damp environment there is no hazard from flash over or leakage between pins.

These connectors must be marked with a particular colour to distinguish them from other circuits. The installation must be easy to reach and disconnect.

The mounting of the units must be such that the mechanical connection can be carried out before the electrical connection.

8.4.5 Battery utilisation

The batteries used as power supply for the operation of the dangerous components are recommended to be hermetically sealed. However, if it is not possible to use these batteries, special precautions must be taken in order to avoid any damage to nearby equipment due to "gassing" of the electrolyte or to corrosion.

8.4.6 Reliability

The PHECs must be so designed that there will not be an inadvertent initiation unless two faults which do not have a common cause occur simultaneously.

A detailed analysis of the expected failures must be carried out taking into account the cases of both single and double failures and showing the consequences which would occur when the vehicle is on the ground before lift-off and in flight during the various phases.

This analysis will be submitted to the Safety Officer of the Range together with the other documents to obtain his approval.

8.5 Pressurised Systems

8.5.1 Pressurised systems are of two types :

a) Normal systems.

b) Vehicle borne systems which, due to weight limitations, cannot meet the requirements of normal industrial legislation.

8.5.2 Normal systems

These systems can meet the requirements of French legislation. Normal systems must be designed to withstand a pressure of six times the working pressure without rupture. Pipe work must be made from qualified material and must be tested to 1½ times the working pressure after assembly. Pressure vessels must be subjected to a pressure test at twice the working pressure before being taken into use.

The super working pressure must be clearly endorsed on each pressure vessel together with the date of test and test pressure. Certification of the appropriate tests and details of any limitation in use must accompany the system when it is delivered. Each vessel must carry a unique serial number.

8.5.3 Vehicle borne systems

In order to comply with weight limitation requirements in vehicle borne systems, a reduced factor of safety must be accepted and may even be less than two to one. The exact ratio will depend on the requirement and the degree of control that can be exercised during manufacture and operational use of the equipment, but the following rules must be applied in all cases :

a) The closest possible quality control must be exercised during manufacture.

b) The vessels are submitted to a hydraulic test and this test pressure must be 1.5 x the working pressure.

c) A number of samples must be tested to destruction which must not occur below the designed ultimate pressure.

d) Each item must be given a serial number and a life history card. A limited life will then be permitted for each item.

e) Where the system is pressurised before lift-off, the operational procedure must specify that all personnel are withdrawn to a safe distance during the period of pressurisation.

During the preparation of the satellite in the payload preparation hall, it is permitted to test the system without special protection when the working pressure is such that the factor of safety is 4.

8.6 Propellants

Propellant systems must be designed so that they can be operated as simply and as safely as possible. This must apply in particular to the filling procedures. These systems and their operation procedures will be submitted to ELDO.

8.7 Radioactive and toxic materials

All devices which include radioactive and toxic materials must be brought to the attention of ELDO as early as possible in the design stage, giving the fullest possible technical details.

All such devices will be submitted to the Range Authorities for approval and must comply with the relevant international and French legislation.

8.8 Submission and approval procedure for the hazardous systems

8.8.1 General

In the following the submission and approval procedures are defined for all documents relative to the hazardous systems and circuits used for the launch from the Guiana site of the ELDO vehicle, the equipment of the Spacecraft Authority included.

8.8.2 Approval

In agreement with the "Règlement de Sauvegarde du CSG", all systems or circuits which can be considered dangerous must be submitted to the Safety Department of CSG for classification and approval.

Approval is obtained in three phases :

- Phase 1 - approval of the design (classification and approval)
- Phase 2 - acceptance of the hardware after manufacture
- Phase 3 - submission and approval of the controlling documents.

Should a system not be considered dangerous by CSG during Phase 1, the following submissions are waived.

8.8.3 Contents of each submission

Phase 1 (design phase)

A set of documents will be submitted which show the operation of the system and full information on the hardware.

Dangerous devices will be indicated, together with the sensitivity of the system.

Phase 2 (manufacture)

The submission will include :

The final manufacturing documents, including the observations which were decided during Phase 1.

The information necessary for the manufacture of the equipment or the installation which are under ELDO or ELDO/CSG responsibility.

The specifications, schematics, results of tests (qualification, reliability, acceptance) and, if required during Phase 1, the specimens of components.

Phase 3

This submission will cover :

The control procedures of the hazardous systems on the site. These procedures will refer to all phases for the preparation of the launch including the functional tests.

8.8.4 Document submission to CSG

All submissions or exchanges of documents with CSG must be carried out through the Division of Technical Coordination (ST4) of the Secretariat with a submission card signed by the design authority.

ST4, in collaboration with the Division of Trials and Range Facilities (ST8), will approve this submission after verification of the interface problems with ground installations and the other stages.

ST4 will send these documents to the competent CSG authority with the submission card asking for the approval of the relative submission phase. A copy of all documentation will also be sent to ELDO Guiana (D/G).

The submission, whatever its phase, must be sent to ELDO in five copies, with the following distribution list :

3 copies	to CSG
1 copy	to D/G
1 copy	to ST4

CSG, after examination, will classify the system, make the necessary remarks and return it to the Secretariat who will inform the department involved.

The documents relative to each phase of submission must be received by the competent authority by the following dates :

Submission Phase 1 - 8 months before the end of the design of the spacecraft.

Submission Phase 2 - 6 months before the end of the manufacture of the spacecraft prototype.

Submission Phase 3 - 4 months before the commencement of the use of the procedures with respect to the plan of work which was submitted at the time of Phase 2. Should this plan not have been submitted during Phase 2, the CSG Safety Department will, at the end of Phase 2, establish a date for the submission of the procedures.

The dates given here are the last limit, but should the number of items to be submitted be lengthy, the relative submissions must be conveniently spaced along the previous period of time.

8.8.5 Submission register

The Secretariat, ST4, will establish and up-date a submission register with a list of all systems and circuits classified as dangerous by CSG, with the dates of the relative submission for each phase and each launch.

For each launch (after the first submission for the F11 vehicle), each design authority will send to the Secretariat a declaration of the condition of the hazardous systems with respect to the previous launch.

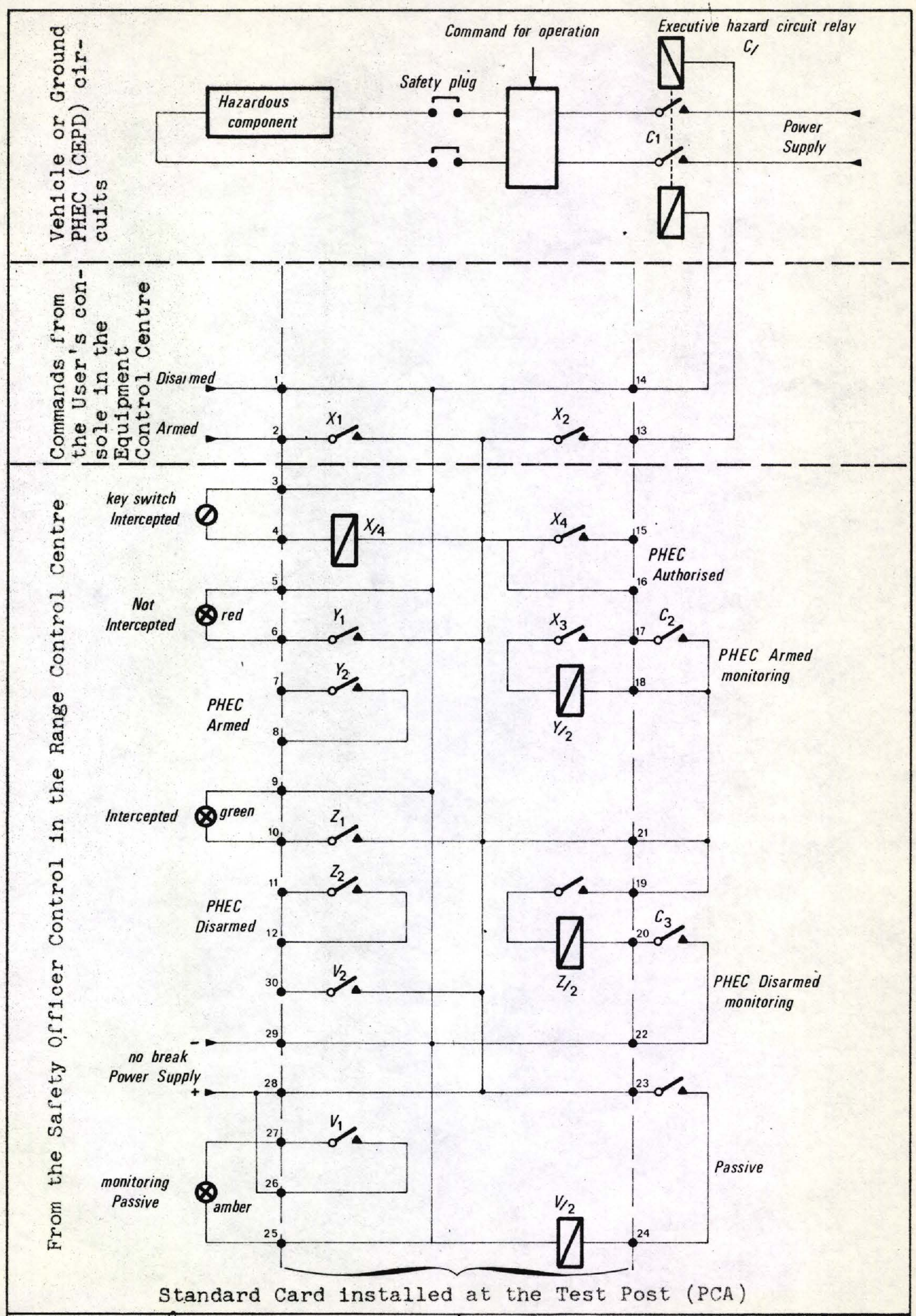
This declaration will be sent by the Secretariat to CSG.

In cases where the systems have been modified, explanations must be given as described in the next paragraph.

8.8.6 Modifications

Each modification must be considered independently from the requirements stated in RT1, as an amendment to the documents which, at the end of the corresponding phases, have been submitted and approved.

The modification must then follow the procedure relative to each phase. However, only the modified documents are to be submitted,with a corresponding submission card.



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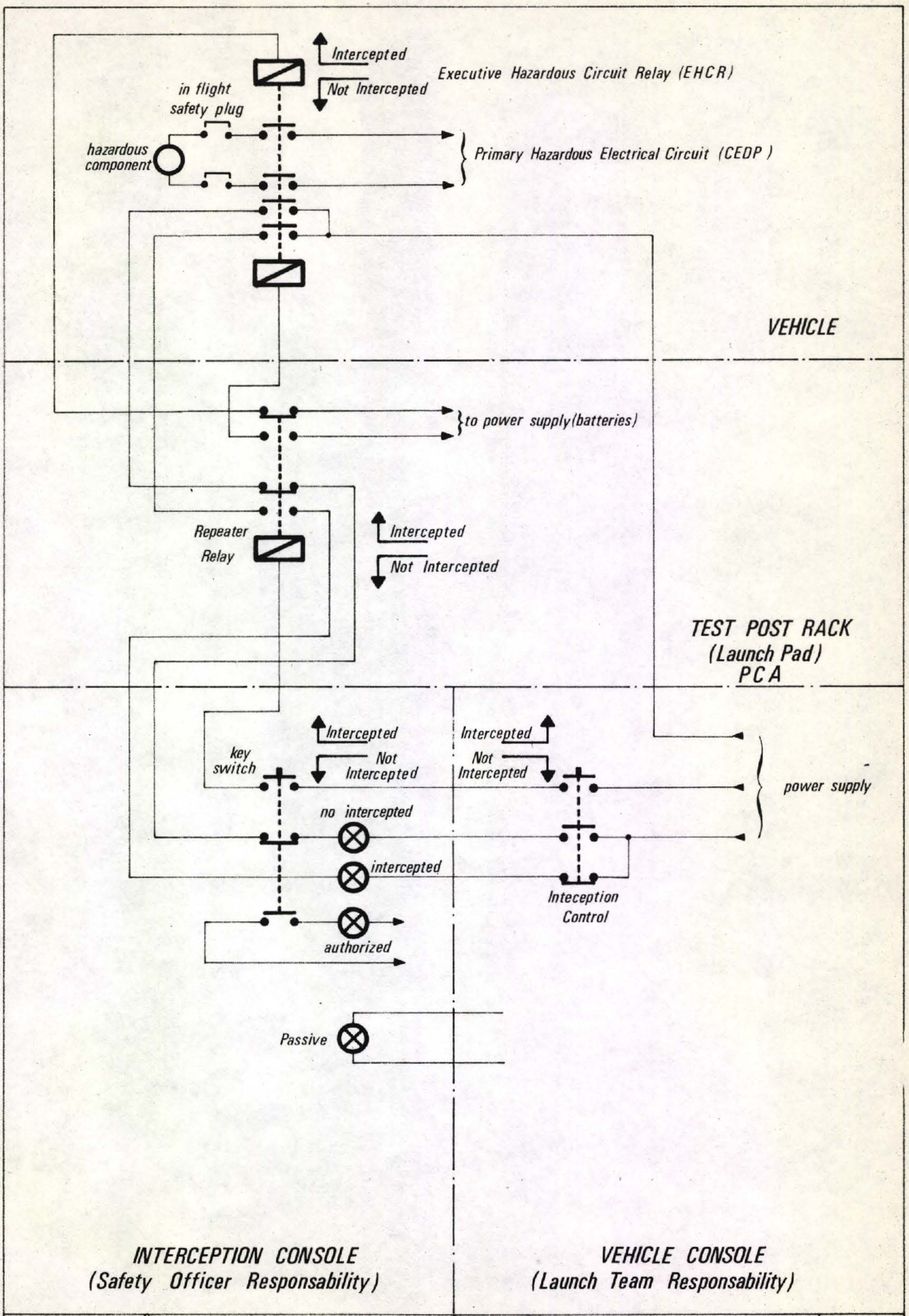

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9. MANAGEMENT SCHEME AND RESPONSIBILITIES

9.1 Organisation and Responsibility Distribution

9.2 Mission Planning

9.3 Documentation Schedule

CHAPTER 9 - MANAGEMENT SCHEME AND RESPONSIBILITIES

9.1 Organisation and Responsibility Distribution

9.1.1 General Organisation

The European Space Vehicle Launcher Development Organisation (ELDO) is responsible for the study, development, modifications, production and launching of Europa I/II launchers.

Launching operations are conducted from the ELDO Equatorial Base (BEC) which has been established in French Guiana - Centre Spatial Guyanais (CSG). The CSG is administered and operated on behalf of the French Government by the Centre National d'Etudes Spatiales (CNES) from their European headquarters at the Brétigny Space Centre (CSB).

The following sections set down the division of responsibility of the existing participating organisations and define the areas of interaction which will occur with potential launcher system users (hereinafter referred to as the Customer).

These organisations are :

a) European Space Vehicle Launcher Development Organisation

b) Centre National d'Etudes Spatiales - Guiana Space Centre

c) Orbital Tracking Network Organisation

d) Customer Organisation.

9.1.1.1 European Space Vehicle Launcher Development Organisation

All liaison between customers and ELDO is managed by the ELDO Customers Management Division which has been set up inside the ELDO Directorate for Operational Launchers (DAF/L)

The Customers Management Division (DAF/L/CM) is responsible for understanding the customers' requirements and for calling on all other ELDO resources to satisfy them.

For each project, DAF/L/CM appoints one engineer, known as the "Mission Engineer" who is responsible for the coordination between the customer and ELDO and in particular for the discussion and solution of interface problems during the overall programme.

The Mission Engineer acts as the focal point for all requirements, from customer to ELDO and vice versa.

The customer must have, on his side, a Launcher Engineer with similar responsibilities.

The Launcher Engineer and the Mission Engineer constitute the Customer/ELDO interface.

The Customers Management Division is assisted by the Technical Coordination Directorate (ST4) and by the Flight Trials and Launching Facilities Directorate (ST8).

9.1.1.2 Guiana Space Centre (CSG)

9.1.1.2.1 General

As noted in para. 9.1.1, the CSG is administered by CNES.

The utilisation of the ELDO Equatorial Base (BEC), which is inside the CSG, is governed by the Agreement on the Construction and Use of the ELDO Equatorial Base at Kourou (French Guiana) and by the Implementing Agreement : Europa I and Europa II.

The Agreement and Implementing Agreements were signed on 25th November 1970 between the French Government and ELDO and between CNES and ELDO.

According to the Agreement, the following definitions apply :

- Guiana Space Centre (CSG)

  All the launch installations and technical and logistic facilities belonging to CNES are placed under the authority of the Director of the CSG.

- ELDO Equatorial Base (BEC)

  All the installations and equipment financed by the Organisation in order to carry out its launchings in Guiana are placed under the authority of the Director ELDO/Guiana.

9.1.1.2.2 Relations between Customer, ELDO and CSG

The relations between the Customer, ELDO and CSG are defined in the Technical Clauses of the Implementing Agreement mentioned in para. 9.1.1.2.1 and are as follows :

a) Head of Mission

He is responsible for the satisfactory completion of the mission in hand; he is kept informed of the progress of operations and any change in the launch order will be subject to his decision.

The Head of Mission is appointed by the Customer or, at the latter's request, by ELDO.

The appointment of the Head of Mission must be discusse between the Customer and ELDO at the beginning of the programme.

b) Launcher Sponsor

He is answerable to the Head of Mission for all matters concerning the launch vehicle and its operation. In particular he gives his opinion and advises the Head of Mission on possible decisions, and may reserve the Organisation's position on the consequences of such decisions. He has authority over the activities of the launch team. At the time of launching he acts in the capacity of launcher expert in the Control Centre.

The Launcher Sponsor is appointed by ELDO.

c) Payload Officer

He is answerable to the Head of Mission for all matters concerning the payload and its operation. In particular he gives his opinion and advises the Head of Mission on possible decisions, and may reserve his position as to the consequences of such decisions. He has authority over the activities of the payload preparation team. At the time of launching he acts in the capacity of payload expert in the Control Centre.

The Payload Officer is appointed by the Customer.

d) Director of Operations

He is the CSG representative vis-à-vis the Head of Mission. In this capacity he is answerable to the latter for the preparation and operation of the CSG facilities; he assists and advises the Head of Mission on the use of these facilities.

He is also responsible for the proper execution of the launch sequence on behalf of the Head of Mission within the framework of the launch order.

The Director of Operations is appointed by the CSG.

e) Safety Officer

He ensures that general and particular safety regulations are complied with. He has the power, during preparation and launch operations and without consulting the Director of Operations, to take any decision he thinks necessary to ensure the safety of the Centre and the local inhabitants, in accordance with the general CSG regulations and with the specific regulations to be drawn up for each launch by joint agreement between CNES, ELDO and the Customer, and set out in the launch order.

However, he reports to the Director of Operations on the state of readiness of the safety facilities and on any important decisions he has taken. The Head of Mission and the Launcher Sponsor are kept informed of such decisions.

The Safety Officer is appointed by the CSG.

f) Operations Officer (ELE)

He coordinates in the launch area all vehicle (launcher and payload) preparation and launching operations. He reports on his work to the Director of Operations within the chronological framework set out in the launch order. He is responsible technically to the Launcher Sponsor for preparation of the launcher.

The Operations Officer (ELE) is appointed by ELDO.

g) Payload Preparation Officer

He is responsible for preparation of the payload.

He is responsible technically to the Payload Officer for such preparation. He reports to the Operations Officer (ELE) within the chronological framework set out in the launch order.

The Payload Preparation Officer is appointed by the Customer.

9.1.1.3 Orbital Tracking Network

ELDO is able to provide advice and introductions to such tracking facilities as :

- ELDO (Australia)
- ESRO
- CNES
- NASA

However, the Customer must formally establish the requirements for the orbital tracking network for the mission.

Normally the ELDO tracking responsibility ends after inflight separation of the satellite from the 3rd stage, in the case of Europa I, and from the 4th stage, in the case of Europa II.

If so required by a customer, ELDO may continue to be responsible for tracking during the satellite flight.

9.1.1.4 Customer Organisation

Irrespective of his internal organisation, the Customer should establish a management and personnel structure corresponding to the ELDO and Range Authority Organisations.

For the purposes of spacecraft design and development, mission definition and similar overall functions, the Customer should appoint a Launcher Engineer and responsible personnel corresponding to the Technical Divisions of ELDO for the Launcher System and other support services.

Additionally, the Customer should provide the services of an on-site team to be responsible for the preparation and operation of the spacecraft equipment.

During the operation phase, this team is to be placed under the authority of the Payload Officer.

The constitution and terms of reference of the Customer organisation shall be established during the mission planning phase.

9.1.2 Technical Responsibility

9.1.2.1 Division of Responsibilities

Subject to an agreed mission definition (see para. 9.3, Mission Planning) which shall be appropriate to the performance capability of the ELDO vehicles, the following responsibilities will apply :

a) ELDO will undertake the following :

- establish the required flight plan and performance of the launch vehicle;
- verify the spacecraft/launcher structural dynamic capability;
- determine all interface requirements;
- confirm the specifications of the launch vehicle and its associated ground equipment;
- include any launcher modifications necessary to fulfil the mission objectives;
- specify all the necessary safety requirements;
- confirm all radio frequency allocations.

b) The Customer shall be responsible for :

- supplying all relevant spacecraft data affecting the launcher system and agreeing with ELDO the content of all necessary interface specifications;
- agreeing the flight plan and vehicle performance with ELDO;
- certifying the compatibility of the spacecraft equipment (both flight units and ground equipment) with that of the launcher system;
- applying for spacecraft radio frequency allocations;
- producing all the required documentation.

9.1.2.2 Spacecraft/Launcher Compatibility

Compatibility of the spacecraft equipment (both flight units and ground equipment) with that of the launcher system is one of the major points requiring certification.

A certification procedure will be set up by the Customer to give evidence that, for the spacecraft items which are of common concern and subject to the agreed interface specifications, three main activities have been successfully achieved : design, development and manufacture.

In particular, certification is required of the qualification and integration tests as explained below.

a) Qualification tests

The qualification tests must be such as to ensure that the spacecraft, even with minor changes in weight and design, can withstand the dynamic environmental loads and the thermal conditions encountered during flight.

After completion of these tests, a functional check must be conducted on the spacecraft which must show that all systems have survived without degradation.

Tests which are not relevant to the ELDO vehicle powered flight, such as vacuum, solar simulation, etc., are not considered here as they fall under the responsibility of the Customer.

A non-exhaustive list of the tests for which qualification must be carried out is given below as an example :

- static and dynamic loads
- vibration loads
- shock
- spacecraft spin-up
- environmental thermal conditions both prior to and during flight
- any other test which may be required by the relevant mission.

b) Integration tests

The integration tests must be such as to ensure that all the spacecraft and vehicle items of common concern are compatible.

A non-exhaustive list of these tests is given below :

Mechanical integration tests

- Interface areas (assembly, umbilicals, etc.)
- Static and dynamic balance (c of g position, moment of inertia axes, etc.)

Electrical and radio electrical tests

- Electrical circuit operation (if any)
- Grounding
- Sequencer and separation signals operation
- Telemetry and monitoring signals
- Radio frequency compatibility
- Safety circuit operation.

Other tests

- Cooling air supply
- Any other test that may be necessary.

A detailed list of these tests, together with the relative specifications, will be compiled for each "Spacecraft Project" after a critical evaluation of its requirements.

9.1.2.3 Range Management

A document "General Operational Request" (Demande Générale d'Opérations) will be compiled by ELDO in compliance with the requirements of the vehicle and the Customer. On the basis of this document, ELDO will ask CNES to determine, organise and put into operation the technical and logistic facilities in support of the preparation and launch of the ELDO vehicles.

9.1.2.4 Launcher System[*] Integration

Subsequently to the manufacture and delivery of the launch vehicle to the ELS and in consideration of the existing launcher system associated ground equipment in French Guiana, the following integration activities are required (see also Chapter 6) :

- preparation of the launch site
- preparation of the launch vehicle stages
- erection of the multistage vehicle
- check-out of the multistage vehicle/site.

In consideration of these activities, the following responsibilities will apply :

a) ELDO will undertake the following :

- provide all equipment and personnel to undertake the launcher system integration
- organise and carry out the integration of the launcher system
- direct and coordinate the installation of the Customer's ground equipment and the erection and integration of the payload in the flight vehicle
- implement appropriate quality control and design/hardware acceptance procedures to ensure compliance with the requirement specifications
- maintain the local assembly areas
- supply local logistic services and transportation.

b) The Customer will be responsible for :

- establishing and defining all spacecraft and spacecraft ground equipment build standards to be achieved, test requirements to be carried out and standard procedures to be adopted
- providing all equipment and personnel to undertake the spacecraft equipment integration with the launcher system
- maintaining appropriate quality control and design/hardware acceptance procedures, to ensure compliance with the requirement specifications.

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[*] Throughout this document the term "Launcher System" is used to define all the items of the vehicle and ground equipment hardware and their associated support activity,documentation procedure,and personnel which are ELDO sponsored.

9.1.2.5 Control of Launch Preparation (see also Chapters 6 and 7)

Following the launcher system and spacecraft integration, the final phase of preparation for launch is put in hand with the object of bringing the complete multistage vehicle and spacecraft to the "ready" state prior to the commencement of the automatic launch sequence.

This activity consists of final vehicle slow time checks, vehicle fuelling and the installation of miscellaneous items of equipment required to be replaced immediately prior to flight.

The responsibilities for work on the various stages of the vehicle and the associated ground equipment and range facilities are the same as for launcher integration, reference para. 9.1.2.4.

Commencing with the erection of the multistage vehicle, all activities concerning the launch vehicle and its operation are directed by the ELDO Launcher Sponsor.

All operations occurring in the last five minutes before launch and those involving the launch itself, are controlled by the automatic sequence unit. The only manual interventions possible during this sequence are the following :

- stop action (which aborts the firing)
- certain commands involving safety
- operations in relation to "Spacecraft in Orbit" which will depend on the nature of the mission and the characteristics of the satellite.

9.2 Mission Planning

9.2.1 Procedure for Initiating the Use of ELDO Facilities

Any spacecraft agency considering a spacecraft launch or an orbital experiment project which it is believed would be suitably accomplished by one of the ELDO launch vehicles, must submit a request to :

Customers Management Division
Directorate of Future Activities
ELDO Secretariat
114 Avenue de Neuilly
92 NEUILLY S/SEINE - France.

This request will contain the following information :

a) The name and address of the Organisation and Sponsor interested in the use of the ELDO facility.

b) Technical data :

- Number of launches required
- Objectives related to each launch
- Mission timescale
- Orbital requirements for each launch
- Spacecraft parameters : mass, geometry, details of experiments to be carried out and/or description of the equipment.

The Customers Management Division will set up suitable liaison channels between ELDO and the Customer, as explained in para. 9.1.1.4, to study mission feasibility and planning and any other associated technical factors.

9.2.2 Negotiating Areas

The Customer, having received confirmation of the acceptance of the mission, will negotiate with the following Organisations :

- ELDO - for the use of the ELDO launcher systems
- CNES - for the use of the range facilities (via ELDO)
- ELDO - if so required - for establishing an orbital tracking network suitable to the orbital mission.

Negotiations with ELDO are required to formally define the following items :

- Executive personnel and their responsibilities
- Executive documentation
- Mandatory requirements for the programme
- Authorities responsible for budget and finance
- Any other items necessary for the mission.

9.2.3 Major Steps in Mission Planning

Up to the date of issue of the document "Launch Request" (see para. 9.3.2.1), the study of the mission will be coordinated by ELDO on a continuing unscheduled basis.

This date will mark the start of a planned activity which will end with the post-launch assessment. All relevant dates are shown in para. 9.3.2 "Mission Related Documents".

9.3 Documentation Schedule

The documentation schedule is fully described in ELDO document, RT.3. In the following, a short description is given.

The documentation is sub-divided into two classes :

- permanent documents
- mission related documents.

Permanent document are independent from the mission profiles; however, they are periodically checked and modified as required.

Mission related documents are produced for each mission and are valid only for that mission.

With the exception of the Customers' Manual, customers are not directly interested in other permanent documents which are quoted here for reference purposes only.

9.3.1 Permanent Documents

Title	Responsible
A1 Europa I and II Customers' Manual	ELDO (ST4 and ST8)
A2 Vehicle and Associated Ground Equipment Data Sheets	ELDO (ST4)
A3 Operating Limitations	ELDO (ST4)
A4 Vehicle and Site Performance Measurements Required	ELDO (ST4)
A5 Standing Assessment References	ELDO (ST4)
A6 Master Index	ELDO (ST8)
A7 Site Preparation Plan	ELDO (ST8)
A8 Detailed Launch Plan	ELDO (ST8)
A9 Standard Procedures for Vehicle	ELDO (ST8)
A10 Daily Plans	ELDO (ST8)
A11 Reference Registers	ELDO (ST4 and ST8)

The purpose of these documents is described hereafter.

9.3.1.1 A1 - Europa I and II Customers' Manual

Provide potential or stated customers with all the various types of information required for drawing up the project of a payload to be launched by a Europa I or Europa II vehicle.

9.3.1.2 A2 - Vehicle and Associated Equipment Data Sheets

Assemble all certified data* in respect of the operation Europa I and II launchers and the associated ground equipment, particularly those required for using the launcher and for studying its performance.

9.3.1.3 A3 - Operating Limitations

Assemble all certified data* concerning the operating limitations of the Europa I and II launches.

9.3.1.4 A4 - Vehicle and Site Performance Measurements Required

To define the measurements to be taken on the ground during firing of a Europa I or II operational launcher.

9.3.1.5 A5 - Standard Assessment References

To produce a reference for assessment of each firing from the point of view of instrumentation and nominal launcher performance; and to define the assessment procedure.

9.3.1.6 A6 - Master Index

This reference document enables the validity of each executive document to be verified. It serves as a catalogue of all executive documentation.

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*Certified data are, in particular, those stated in the technical clauses of the contracts concluded with firms for manufacturing the operational launchers or, in the case of the ground equipment, those guaranteed by the ground equipment design certificate and ground equipment hardware certificate.

9.3.1.7 A7 - Site Preparation Plan

To determine the workload on the site between two launchings and to present it as a bar-chart taking into account the logical relation between the various activities and a number of key dates.

9.3.1.8 A8 - Detailed Launch Plan (DLP)

This is an operational document whose main aim is to prepare the ELDO team's coordinating task on the range.

9.3.1.9 A9 - Standard Procedures for the Vehicle

This is an operational document whose aim it is to define with all required detail the successive operations necessary to carrying out a given activity. In no case may an operative deviate from the written procedure which he should have at hand during the activity.

9.3.1.10 A10 - Daily Plans

This operational document fulfills the same functions as the standard procedures but is drawn up to cover the most complex exercises in order to facilitate coordination of parallel activities which are closely related to time.

9.3.1.11 All - Reference Registers

This document which is compiled by the various firms lists all documentation required for the manufacture and operation of a piece of equipment (whether it be vehicle or ground equipment).

9.3.2. Mission Related Documents

Due Date (months)	Title		Originator
L-18	B 1	Launch Request (Demande de lancement)	Customer
L-16	B 2	Trajectory plan	ELDO (ST4)
L-15	B 3	Vehicle and Ground Equipment Technical Requirements	ELDO (ST4)
L-14	B 4	General Operation Request (Demande Générale d'Opérations)	ELDO (ST8)
L-13	B 5	Configuration of Payload and associated ground equipment	Customer
L-11	B 6	General Operational Programme (Programme Général d'Opérations)	CNES
L-10	B 7	Flight Plan	ELDO (ST4)
L-10	B 8	Vehicle/Spacecraft Compatibility Design Certificate	ELDO (ST4)
L-8	B 9	Orbital operational requirements	Customer
L-8	B 10	Operational requirements for the spacecraft	Customer
L-8	B 11	Overall launch plan	ELDO (ST8)
L-8 to L-6	B 12	General Operational Request Supplementary Documents (Document Complémentaire à la Demande Générale d'Opérations)	ELDO (ST8)
L-6	B 13	"Master Index" Amendments (A6)	ELDO (ST8)
L-6	B 14	"Site Preparation Plan" Amendments (A7)	ELDO (ST8)
L-4	B 15	Standard Procedures for Spacecraft	Customer
L-4	B 16	Launch Order (Ordre de lancement)	CNES
L-3	B 17	"Detailed Launch Plan" Amendments (A8)	ELDO (ST8)
L-2	B 18	Global Network Operational Plan	CNES
L-4 to L-1	B 19	"Standard Procedures for Vehicle" Amendments (A9)	ELDO (ST8)
L-4 to L-1	B 20	"Daily Plans" Amendments (A10)	ELDO (ST8)
L-0.5	B 21	Vehicle/Spacecraft compatibility test certificate	ELDO (ST4)
L+4	B 22	Launch Assessment Reports	ELDO (ST4)

The purpose of these documents is described hereafter. For the documents to be issued by the customer, the desired contents are also shown.

9.3.2.1 B1 - Launch Request (Demande de Lancement)

A - Purpose

In this document the customer sets out the technical clauses of the mission following initial contact with ELDO. It serves to define :

- the trajectory plan
- the vehicle and ground equipment technical requirements
- the general operational request
- the radio-electric interference tests
- the preliminary structural calculations (natural modes).

This document should contain a full choice made amongst the options open to the customer (e.g. for EUROPA II, location of the umbilical plug, speed of rotation of the composite unit, etc...) should the available options not satisfy mission requirements, deviations from documents A1 (Customers' Manual) and A2 (Data Sheets) accepted in advance by ELDO should be expressly specified.

Some special points are dealt with in more detail in the following documents described below B5, B9, B10, B15.

B - Contents

B.1 General Information

B.1.1 Organisation

Name and address of customer together with an outline organisation chart showing the customers services and giving the name of the person or persons to be contacted (if necessary, depending on the nature of the matter dealt with).

B.1.2 Objectives

Definition of the general mission objectives including any of ELDO's own objectives included in the firing with the agreement of the customer.

B.1.3 Planning

Definition of key dates, already approved by ELDO, in agreement with the present Technical Regulation No 3. Approximate composition of the teams responsible for preparation and checkout of the payload in Guiana prior to launching and the time required for these activities.

B.2 Orbit

Definition of the nominal orbit in the form of orbit parameters or position/velocity vector at injection into final orbit; indication of maximum permissible dispersion, preferably as a covariant matrix.

B.3 Payload

Basic characteristics of the payload :

- Mass
- Position of centre of gravity
- Moments of inertia
- Maximum volume
- Simulation model for determining the natural modes of the overall launcher
- Speed of rotation (Europa II only)

Where these values cannot be exactly stated the variation range should be indicated.

Where the alignment tolerances specified in the EUROPA I and II customers' manual cannot be met, a concession should be requested stating the new values.

B.4 Mechanical interface

- Choice of separation system (Europa I only)
- Position of the umbilical plug (height and radial distance)
- Definition of elements to be accessible behind the fairing hatches
- Utilisation of the useful volume requiring ELDO's prior agreement (Europa II only. Consult document A1)

B.5 Radio-electric interface

- Frequency of radio-electric transmission and reception
- Type of HF modulation
- Maximum transmission power and reception sensitivity
- Scheduled aerial gain
- Periods of utilisation (including the launch preparation phase)
- Imposed forms for parasitic spectra.

B.6 Operational aspect

The information is requested at this stage only to enable an evaluation to be made of the operational facilities required for the mission. In particular, the following elements should be supplied :

- Main telemetry characteristics (type of modulation, pass bands)
- Approximate number of parameters to be recorded (prior to and during flight)
- Main telecommand characteristics
- Approximate number of stop actions
- Special storage or handling or operating facilities
- Any operational aspect which may require new work or modifications liable to cause considerable delays.

B.7 Special requirements

This item covers all special payload requirements not specified in documents A1 and A2. As a non-exhaustive example, the constraints in the following areas can be given :

- Thermal
- Apogee motor propellants
- Power supplies
- Range and flight safety.

9.3.2.2 B2 - Trajectory Plan

To propose a trajectory compatible with the mission, enabling a certain number of studies and verifications to be made, viz :

- Check of structural behaviour of the launcher in flight (flight loading and kinetic heating)
- Check the validity of the fairing jettison time
- Visibility from ground stations (tracking, telemetry and telecommand)
- Definition of the inertial computer flight programme.

Should difficulties appear in one of the above mentioned areas a new issue of this document will become necessary. The aim is to obtain a trajectory which has satisfied the above checks 12 months prior to launching.

9.3.2.3 B3 - Vehicle and Associated Ground Equipment Technical Requirements

To compile all modifications to the launcher and ground equipment decided on to meet the mission objectives.

Note 1 - Notification of launcher modifications to the firms is an independant activity which may begin prior to publication of this document.

Note 2 - In cases where modifications are applied not only to the specific mission but also to the operational standard, this document will serve as a basis for updating the standing documentation, A1 (Customers' Manual) A2 (Data Sheets) and A11 (Reference Registers).

9.3.2.4 B4 - General Operation Request
(Demande Générale d'Opérations)

To communicate to CNES (Division Opérations - Bretigny) the information required for identifying, organising and setting up the technical and logistic facilities required of CSG as launch support.

9.3.2.5 B5 - Configuration of payload and associated ground equipment

A - Purpose

To fully define the configuration of the payload and of its associated ground equipment to permit :

- Issue of the flight plan
- Where appropriate, signature of document B8 "Vehicle/Spacecraft Compatibility Design Certificate"

B - Contents

- Drawings setting out the dimensions of the payload (taking into account the structural deformation)
- Diagrams showing the functioning of the equipment (where such functioning affects the electrical interfaces of the launcher or of the ground test equipment)
- Full definition of the mechanical and electrical interfaces (payload and ground equipment)
- Definitive payload mass breakdown
- Detailed list of parameters to be checked prior to launch, together with the sequence and stop action logic
- Sequence of events during automatic sequence and flight
- Details of all hazardous systems (electrical, chemical, pressurisation etc...)
- Cabling between the payload and the ground test equipment
- Radio-electric characteristics (aerial diagrams, parasitic radiation, etc...).

9.3.2.6 B6 - General Operational Programme (Programme Général d'Opérations)

To officially lay down the facilities operated by CNES at ELDO's request and to fix the division of responsibilities for the firing between the various parties. This document constitutes the agreement between CNES and ELDO.

9.3.2.7 B7 - Flight Plan

To define in detail the trajectory data in order to effect various adjustments, to forecast the trajectory and to evaluate the vehicle behaviour after lift-off.

9.3.2.8 B8 - Vehicle/Spacecraft Compatibility Design Certificate

This document certifies the compatibility of the payload configuration with that of the launcher, and states the means used for checking.

Note : This document thus covers those aspects of compatibility which could involve a risk for the launcher on account of the payload, but not vice versa, these aspects being the customer's responsibility.

9.3.2.9 B9 - Orbital Operational Requirements

A - Purpose

To enable the required facilities to be defined with the aid of document B18 (Global Network Operational Plan).

Observation

Where the originator is the customer, this document is not obligatory. It need only be produced if the customer charges ELDO with technical coordination of the orbit analysis facilities.

B - Contents

Request for real time measurements during the orbital phase covering :

- tracking (stating required accuracy)

- telemetry)
- ((nature and time of operation)
- telecommand)

together with the time and place at which this information should be available.

9.3.2.10 B10 - Operational Requirements for the Spacecraft

A - Purpose

The purpose of this document is to define the activities and facilities required for preparing the payload and, where appropriate, for operating it during the launcher propulsion phase.

B - Contents

This document gives the definitive status of the data already contained in paras. B.6 and B.7 of document B1 "Launch Request". It should state :

- the Guiana preparation phase programme from arrival of the payload up to its erection on the vehicle with details of the workload for each working day in the programme.
- A list of required facilities (technical and logistic support) including special equipment, lifting and handling equipment, transport, etc.
- The structure of the payload operating team including arrival and departure dates for such personnel.
- The detailed programme of tests to which the payload is to be subjected whilst mounted on the vehicle. This programme should state the test procedures to be used and identify those activities requiring assistance from ELDO or CSG staff, and also those bearing consequences for ground or flight safety. In particular, the technical characteristics of all electrical, electronic (telemetry, telecommand) and pyrotechnical equipment installed in the payload should be stated, as should those of all ancillary systems such as pressurisation, stabilisation, attitude control, etc.
- The detailed automatic countdown sequence including scheduled stop actions.
- The operational limitations and constraints during the various preparation and launch phases, including the safety aspect.

9.3.2.11 B11 - Overall Launch Plan

Communicate to CNES the key dates for preparation. This document also enables the various objectives to be known within ELDO and at the contractors.

9.3.2.12 B12 - General Operational Request - Supplementary Documents (Document Complémentaire à la Demande Générale d'Opérations)

These sheets are executive documents. They define in detail ELDO's final requests for a specific launching in particular areas.

9.3.2.13 B13 - "Master Index" Amendments (A6)

Cover the particularities of the "Master Index" A6 specific to the firing in question. Refer to document A6.

9.3.2.14 B14 - "Site Preparation Plan" Amendments (A7)

Cover the particularities of the "Site Preparation Plan" A7 specific to the firing in question. Refer to document A7.

9.3.2.15 B15 - Standard Procedures for Spacecraft

A - Purpose

This is an operational document whose purpose is to define in all required detail the sequence of operations to be carried out in accomplishing a specific activity. In no case may the operative deviate from the written procedure which he must have at hand during the operation.

B - Contents

This is an amendable document established for a specific system and whose sections correspond to the various activities to be carried out on the range which involve use of the system.

Each section contains the following information :

- originator
- required personnel and equipment
- intercom network to be used
- chronology of the various elementary operations.

These procedures are incorporated in the amendment to the "Master Index" for the firing in question and are approved by ELDO. The joint ELDO/customer procedures are dealt with by ELDO in the same way as the vehicle procedures.

9.3.2.16 B16 - Launch Order (Ordre de lancement)

This is an executive document defining in detail the operation of facilities by CNES, and officially confirms the special conditions of the launching.

9.3.2.17 B17 - "Detailed Launch Plan" Amendments (A8)

Cover the particularities of the Detailed Launch Plan A8 specific to the launch in question. Refer to document A8.

9.3.2.18 B18 - Global Network Operational Plan

This document is dependent on document B9 (Orbital Operational Requirements) for the same reasons.

It compiles the technical information required for the orbital phase and organises the tracking, telemetry and telecommand operations, and the reduction of the data obtained.

Observation

This document is drawn up in collaboration with the outside body responsible for coordination of orbital operations.

9.3.2.19 B19 - "Standard Procedures for Vehicle" Amendments (A9)

Cover the particularities of "Standard Procedures for Vehicle" A9 specific to the firing in question. Refer in document A9.

9.3.2.20 B20 - "Daily Plans" Amendments (A10)

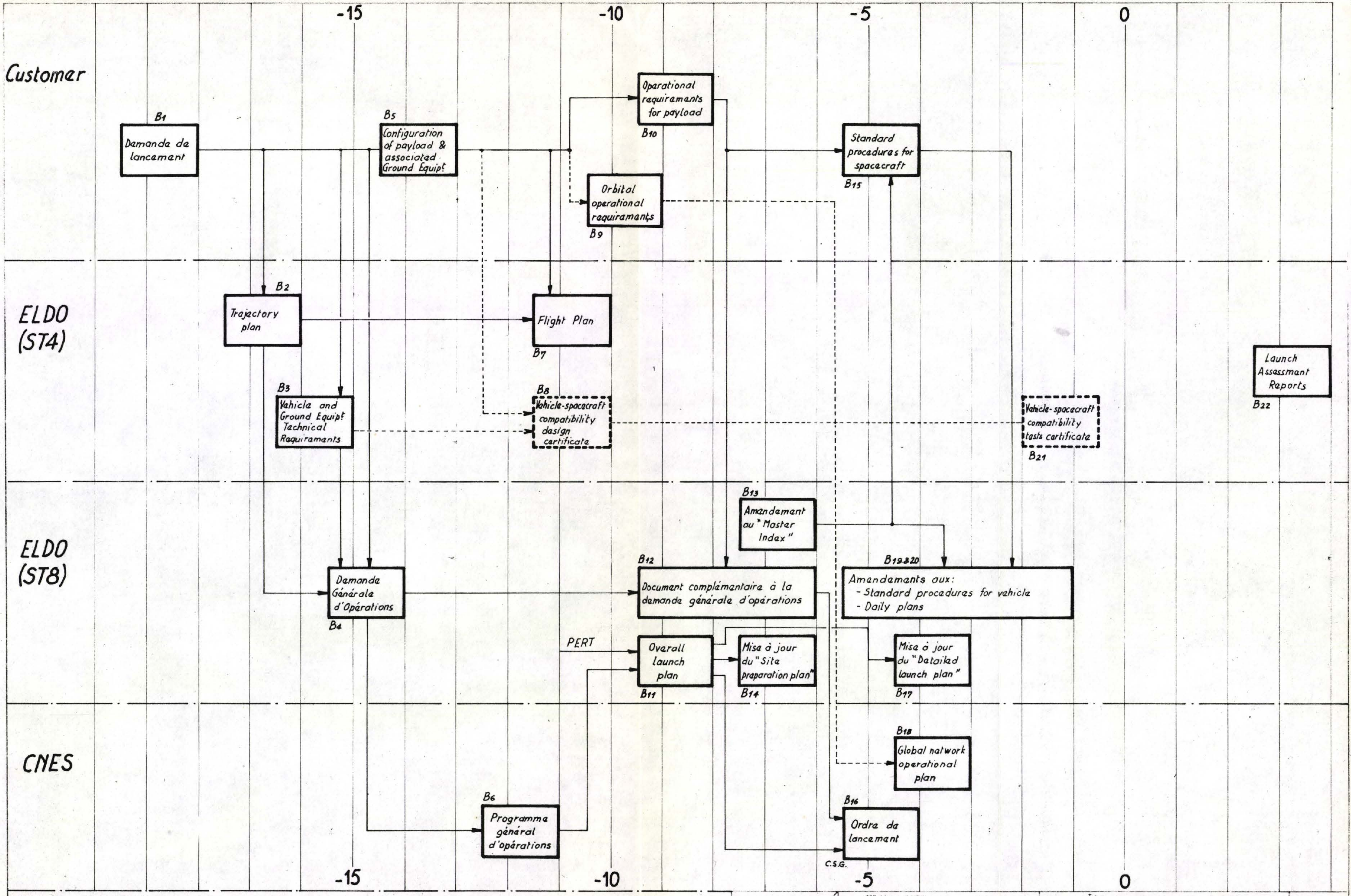
Cover the particularities of "Daily Plans" A10 specific to the firing in question. Refer to document A10.

9.3.2.21 B21 - Vehicle/Spacecraft Compatibility Test Certificate

This document certifies that the tests foreseen in document B8 (Vehicle/Spacecraft Compatibility Design Certificate) have been carried out satisfactorily.

9.3.2.22 B22 - Launch Assessment Reports

To prove correct functioning of the launcher during the firing by comparison of the data shown in document A5 (Standing Assessment References) with the actual measurements. Where there has been a malfunction, this is identified and the implicationsfor mission fulfilment examined.


-15
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Customer
ELDO (ST4)
ELDO (ST8)
CNES
B1
Demande de lancement
B5
Configuration of payload & associated Ground Equipt
Operational requirements for payload
B10
Orbital operational requirements
B9
Standard procedures for spacecraft
B15
B2
Trajectory plan
Flight Plan
B7
Launch Assessment Reports
B22
B3
Vehicle and Ground Equipt Technical Requirements
B8
Vehicle-spacecraft compatibility design certificate
Vehicle-spacecraft compatibility tests certificate
B21
B13
Amendement au "Master Index"
B12
Document complémentaire à la demande générale d'opérations
B19&20
Amendements aux:
- Standard procedures for vehicle
- Daily plans
Demande Générale d'Opérations
B4
PERT
Overall launch plan
B11
Mise à jour du "Site preparation plan"
B14
Mise à jour du "Detailed launch plan"
B17
B18
Global network operational plan
B16
Ordre de lancement
C.S.G.
B6
Programme général d'opérations
-15
-10
-5
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N.B. For EUROPA 2 supplementary programme firings the customer is replaced by ELDO (ST4 or ST8)

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Vérifié par
1er Mars 1971

Titre **Documents produced for each firing.**

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Figure AL.0